Ecosystem Considerations for 1999

Compiled and Reviewed by
The Plan Teams for the Groundfish Fisheries
of the Bering Sea, Aleutian Islands, and Gulf of Alaska

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INTRODUCTION

Since 1995, the North Pacific Fishery Management Councils (NPFMC) Groundfish Plan Teams have prepared a separate Ecosystem Considerations section to the annual SAFE report. The intent of the Ecosystems Considerations section is to provide the Council with information about the effects of fishing from a ecosystems perspective, and the effects of environmental change on fish stocks. The effects of fishing on ecosystems have not been incorporated into most stock assessments, in part due to data limitations. Most single species models cannot directly incorporate the breadth and complexity of much of this information. ABC recommendations may or may not reflect discussion regarding ecosystem considerations. This information is useful for effective fishery management and maintaining sustainability of marine ecosystems. The Ecosystems Considerations chapter attempts to bridge this gap by identifying specific ecosystem concerns that should be considered by fishery managers, particularly during the annual process of setting catch limits on groundfish.

Each new Ecosystem Considerations report provides updates and new information to supplement the original report. The original 1995 report presented a compendium of general information on the Bering Sea, Aleutian Island, and Gulf of Alaska ecosystems as well as a general discussion of ecosystem management. The 1996 Ecosystems Considerations report provided additional information on biological features of the North Pacific, and highlighted the effects of bycatch and discards on the ecosystem. The 1997 Ecosystems Considerations report provided a review of ecosystem-based management literature and ongoing ecosystem research, and provided supplemental information on seabirds and marine mammals. The 1998 edition provided information on the precautionary approach, essential fish habitat, an overview of the effects of fishing gear on habitat, el Nino, collection of local knowledge, and other ecosystem information. If you wish to obtain a copy of a previous Ecosystem Consideration Chapter, please contact the Council office (907) 271-2809.

ECOSYSTEM CONSIDERATIONS

What are the Plan Team's Specific Ecosystem Concerns?

As in previous years, there are a number of specific ecosystem concerns that the Council and NMFS should consider in the process of setting next year's groundfish TACs. While the Teams are not able to provide quantitative recommendations, these concerns suggest serious consideration of more conservative management choices wherever those options exist. Listed below are the team's ecosystem concerns for 1999; the list is not prioritized.

1. **Fishery Effects on Species Composition** -- Large differences exist in the harvest rates of groundfish species off Alaska--some groundfish (such as pollock, cod, sablefish, and rockfish) are harvested at or close to their F_{abc} levels, whereas other species (such as flatfish) are harvested at substantially lower levels. Flatfishes have been exploited substantially below ABCs in both the BSAI and GOA because the flatfish trawl fishery is constrained by bycatch limits for prohibited species (like crabs and Pacific halibut) and a lower commercial value for flatfish. Low catches of flatfish, combined with good recruitment, have kept their biomass high. High biomasses of predator species may have great impacts on the trophodynamics of the marine ecosystem and shift the species composition. The flatfishes are major predators of forage fish (including juvenile pollock) and benthic organisms such as crabs and shrimp. Additionally, large flatfish may compete with marine mammals and others in

the upper trophic levels. The Plan Team requests analysis of the long-term implications of disproportionate harvest rates. The Team would like to review this analysis in September.

2. **Impacts of Fishing Gear on Habitat and Ecosystems** -- The Teams are concerned about the effects of fishing on seafloor habitats and trophic dynamics, and the Teams support continued research on this question. There are numerous papers on this subject published in the literature, and a summary was provided as a section in the 1998 Ecosystems Considerations chapter. Some research has shown that bottom trawling and other gear types can alter the bottom structure, sediments, and nutrient cycling in certain situations. Most research has been done on trawl gear. Recent research in Alaska indicates that bottom trawling may damage a high percentage of sponges, sea whips, and corals encountered by a trawl. A section on the use of Marine Reserves as a mitigation measure is included in the 1999 Ecosystem Considerations Chapter.

3. **Ecosystem Change** -- The 1998 draft included a section on "ecosystem change" and ongoing research on the subject. Shifts between warm and cool eras appear to occur on a decadal or greater (e.g., 18.6 years) frequency in the North Pacific Ocean. Such shifts in physical conditions may also be associated with changes in ocean productivity, affecting plankton, nektonic fish, cephalopods and many other marine organisms. Year class strengths of commercially important species have also been related to oceanic temperature conditions. Compelling links between ocean conditions and production can be seen in strong year classes of a number of Bering Sea fish stocks (pollock, Pacific cod, Pacific herring) spawned at the onset of warm current regimes (1976-77) that are accompanied by apparent simultaneous decline of some other stocks (e.g. capelin, shrimps, and king crabs). Ocean conditions can cause significant, rapid, and sometimes unexpected changes in ecosystem components. To address this uncertainty about ecosystem change, the Plan Team encourages the Council to take a precautionary approach to all fishery management policies, including the annual TAC specifications. The new format of future ecosystem chapters should provide more information to evaluate this concern.

4. **Steller Sea Lion Trends** -- The Plan Teams identified several fishery concerns relevant to the continuing decline of Steller sea lions in the BSAI and GOA. One was diet diversity of sea lions. Previous analysis suggests that sea lions need a variety of prey available, perhaps as a buffer to significant changes in abundance of any single prey. As the sea lion population is endangered and continuing to decline in the Aleutian Islands, the Council should also consider sea lion concerns when setting a TAC for Atka mackerel for the Aleutian area. The Team also remains concerned about intensive removals of prey for Steller sea lions. Temporal and spatial aspects of fish removals should be thoroughly considered in setting ABCs, managing fisheries, and recovering protected species.

   The 1994 reauthorization of the Marine Mammal Protection Act (MMPA) provided for a long-term regime for managing marine mammal takes in commercial fisheries. The cornerstone of the new regime is the calculation of Potential Biological Removals (PBRs) for each marine mammal stock. A list of the PBRs for all the marine mammal stocks off Alaska has been contained in previous ecosystem chapters. The PBRs, the level of human caused mortality, and the overall status of the marine mammal stock are to be used to prioritize management of marine mammal/fisheries interactions. The overall goal is to eventually reduce the levels of marine mammal incidental takes to levels approaching zero. Current levels of marine mammal takes in the groundfish fisheries are already quite low. Reduction of subsistence takes exceeding PBRs will be approached through co-management of the resources with Alaska natives.

What's New in Ecosystem-Based Management?

A number of workshops and symposia were held over the past year on the Bering Sea ecosystem and ecosystem-based management. Executive summaries from these meetings are provided in this section.

Bering Sea Ecosystem Research Planning

Summary by Pat Livingston

The Bering Sea has been the focus of many research planning efforts in recent years. One of these efforts was a scientific workshop on the Bering Sea ecosystem, sponsored by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of the Interior, and the Alaska Department of Fish and Game that was held December 4-5, 1997 in Anchorage. The purpose of this workshop was to promote research coordination and data sharing among organizations that study and utilize resources of the Bering Sea. Several recommendations arose from this workshop including:

- develop and enhance a web site to facilitate research planning and sharing of information,
- continue efforts in building a metadatabase (a database that lists types of available data and the holders of those data) for the Bering Sea,
- identify mechanisms for Alaskan Natives and coastal communities to communicate traditional and local knowledge and to participate in research, and
- develop an integrated Bering Sea Ecosystem research plan.

A great deal of progress has been made on these recommendations since the December, 1997 workshop. An existing web-site, developed and maintained by NOAA's Pacific Marine Environmental Laboratory, is undergoing revision to serve as a primary site to enhance research planning and information sharing on the Bering Sea. The web page address is: http://www.pmel.noaa.gov/bering/. This web site also contains links to the Bering Sea biophysical metadata base that is under construction.

The last two recommendations have been acted upon through the development of a draft Bering Sea Ecosystem Research Plan. This Research Plan summarizes and integrates the hypotheses, key scientific questions and approaches from past planning documents for the Bering Sea. The main thrust of the plan is two-fold. First, it seeks to investigate how human activities such as fishing, introduction of pollutants and other materials, and coastal development impact ecosystem health, production and composition. Secondly, it outlines the importance of understanding how climate affects individual species and productivity of the Bering Sea. One use of the plan will be to guide future research efforts to be undertaken through the newly-forming North Pacific Research Board.

The first draft of the Bering Sea Ecosystem Research Plan was completed in April 1998 through a collaborative effort of scientists from NOAA, U.S. Dept. of Interior, and Alaska Department of Fish and Game. A workshop was held June 2-3, 1998 in Anchorage to get feedback on the plan from a broader constituency. The research plan for the Bering Sea Ecosystem was updated in September, 1998 to include the viewpoints of university researchers, conservation organizations, native groups, fishing industry members and other constituents. The plan outlines the most pressing fishery management and marine ecosystem information needs that require further research efforts. Research approaches such as monitoring, analysis of existing data, field and lab research, and modeling are outlined in detail along with the feasibility and study duration of various approaches. The Bering Sea Ecosystem Research Plan has been published and distributed. It is available from NOAA's Bering Sea and North Pacific Ocean theme page (http://www.pmel.noaa.gov/bering/) by linking to Interagency Exchange of Research Plans and Schedules. The reports of the two Bering Sea Ecosystem Workshops can also be found at the same web site. This research plan will be presented to the North Pacific Research Board that is now being formed and awaiting appropriation of fiscal year 1999 research funds by Congress. Although the focus has been on the Bering Sea, additional research on the GOA ecosystem is being considered.

National Research Council Report "Sustaining Marine Fisheries"

Summary by Dave Witherell

A Committee on Ecosystem Management for Sustainable Marine Fisheries, established by the National Research Council, recently released a report of its findings. The Committee was tasked to "assess the current state of fisheries resources; the basis for success and failure in marine fisheries management (including the role of science); and the implications of fishery activities to ecosystem structure and function. Each activity [was to] be considered relative to sustaining populations of fish and other marine resources."

A prepublication of their report, entitled "Sustaining Marine Fisheries" was released on the Internet (http://www.nap.edu/readingroom/enter2.cgi?0309055261.html) in October 1998. The final report will be available through the National Academy press in early 1999. The report provides a review of sustainablility and ecosystem-based management, the status of marine fisheries worldwide, an the effects of fishing on marine ecosystems. The Committee provided a number of recommendations and they are summarized in the adjacent table.

Summary of the NRC Committee's recommendations.

1. Adopt conservative harvest levels for single species fisheries.
2. Incorporate ecosystem considerations into fishery management decisions.
3. Adopt a precautionary approach to deal with uncertainty.
4. Reduce excess fishing capacity and define and assign fishing rights.
5. Establish marine protected areas as a buffer for uncertainty.
6. Include bycatch mortality in TAC accounting.
7. Develop institutions to achieve goals.
8. Conduct more research on structure and function of marine ecosystems.

Workshop on Marine Harvest Refugia for West Coast Rockfish

On September 17-19, 1997, the National Marine Fisheries Service held a workshop to evaluate marine harvest refugia to manage, protect, and conserve rockfish populations on the west coast of North America. Proceedings of the workshop were published as a NOAA Technical Memorandum (NOAA-TM-NMFS-SWFSC-225) in August 1998. Copies of the Tech Memo are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22167. The following are the recommendations from the workshops working groups.

Need for Rockfish Refugia. There was general consensus that marine harvest refugia exemplify a precautionary approach to the management and conservation of rockfish resources on the west coast. It was recognized that, while there are limits to our scientific knowledge of rockfish ecology, we have sufficient understanding of the problems associated with their management and conservation to proceed with the process of implementing refugia. The goals and objectives of establishing harvest refugia and the problems being addressed by this process must be clearly defined at the onset of planning. The expected level of success and how it will be evaluated should be established prior to refugia implementation.

Key Problems in Managing Rockfish Populations and Associated Expectations to Refugia. Marine harvest refugia are one of the few constructive ways to address protection and conservation of essential fish habitat, and offer the opportunity for habitat to recover from disturbances including impacts from fishing gear. Secondly, there are currently no effective management practices to deal with infrequent recruitment and its interdecadal variability which are exhibited by rockfishes. Refugia hold promise in addressing this problem by allowing researchers to separate environmental variables from fishery effects. Further, current rockfish assemblage management can result in serial overfishing and overfishing on the weakest stocks. Refugia will allow us to incorporate ecosystem principles into fisheries assemblage management. Refugia also provide the needed baseline data for more accurate stock assessments.

Design Considerations for Rockfish Refugia. Three different scenarios for developing rockfish harvest refugia were recommended based on the goals and objectives for establishing the refugia. These scenarios range from small no-take heritage sites used for research and to protect key habitats and species to large harvest refugia used for sustainable fisheries management. Each scenario includes different design characteristics and subsequent levels of protection. These distinct scenarios provide greatly different benefits. A coast-wide network of marine refugia could include all three levels of resource protection.

Consideration of Stakeholders. It was agreed that stakeholders need to be identified early in the process of implementing rockfish refugia. Stakeholders clearly need to be involved in identifying the reasons for establishing the refugia, and in conceptualizing, designing, implementing and evaluating them. A network among all those involved in the refugia process should consider interstate and international issues of rockfish resource management.

Compliance and Enforcement. Public education should reinforce compliance and lessen the need for enforcement, but enforcement will be necessary and should be considered in the design and implementation process. Assignment of property rights, which would encourage fishermen to take a personal interest in the protection of the refuge, would foster compliance. Vessel-tracking-systems, an attractive aid to enforcement, need to be considered. Planning should carefully consider the range of needs and concerns, resources available, and opportunities for cooperation among local, state, and federal entities in promoting compliance and carrying out enforcement.

Workshop on Ecosystem-based Management in the Bering Sea

> On October 6-7, 1997, the Center for Marine Conservation held a workshop on ecosystem-based management in the Bering Sea. Copies of the Workshop proceedings are available from the Center for Marine conservation for $12.50, including postage. Contact Linda Sinclair at (202) 429-5609. The following is an Executive Summary of the workshop, excerpted with permission from the Center for Marine Conservation.

EXECUTIVE SUMMARY

The Bering Sea is a large, diverse, and rich marine ecosystem. Considered by scientists to be one of the most highly productive marine ecosystems in the world, humans have long extracted a wealth of resources, both biological and mineral, from the Bering Sea. Indeed, Native cultures have inhabited the Bering Sea region for more than 10,000 years. While considered by many to be a comparatively well managed ecosystem, recent fluctuations in populations of certain species have raised concerns about the continued health of the Bering Sea ecosystem, and the species, including humans, that depend on it.

In October 1997, the Center for Marine Conservation and Alaska Sea Grant convened a two-day interdisciplinary workshop in Anchorage to explore issues related to ecosystem-based management in the Bering Sea. The nearly 50 invited participants and more than 20 observers included scientists from Russia, Canada, the United Kingdom, and the United States; Native Alaskans; commercial fishers; representatives of state and federal management agencies; and conservationists.

Formal presentations were limited to a few key speakers who provided a common base of knowledge from which all participants could start and who introduced certain concepts for specific discussions. Russian scientists and Native Alaskans were asked to provide their unique perspectives on the Bering Sea in two panel discussions.

The bulk of the workshop was devoted to informal group discussions. A professional facilitator led the entire group in several mediated dialogues, which centered on precautionary approaches to management in the face of limited knowledge, adaptive management options, and options and recommendations for action in the Bering Sea. At one point, workshop participants broke into three smaller groups to explore the potential for using adaptive management techniques to increase our knowledge of ecosystem functions in the Bering Sea.

Although the conveners specifically chose not to force development of consensus among such a large, diverse group in such a short time, a number of common themes did emerge from the discussions. Most participants appeared to agree that problems exist or are imminent in the Bering Sea, and many suggested the need for a process to develop common goals for management. Many participants reiterated the need to better appreciate and use the wealth of information that already exists about the Bering Sea, including information from Natives and fishers, both for incorporation in current management processes and retrospective, integrative analysis.

There was wide agreement that the Bering Sea presents considerable opportunities for management-based experiments to gain new insights into ecosystem functions, the causes for declines of certain species, and development of more holistic management regimes. Considerable attention was paid to the issue of the timing and spacing of fishing, the potential for localized fish depletions to affect species that may depend on fish such as pollock for food at critical times (e.g., seabirds during breeding cycles and juvenile Steller sea lion feeding), and the need to better disperse the fishery in time and space. Concerns were raised about the impacts of bottom trawling on benthic habitats and the implications for food chains. Much support was expressed for increased U.S.-Russian cooperation on all aspects of research and management in the Bering

Sea. Finally, a number of participants noted that the open dialogue begun at the workshop should be continued.

Based on what was learned through this workshop, the Center for Marine Conservation offered a number of recommendations for future actions in the arenas of information exchange and cooperation, research, and management. The CMC's recommendations are listed in the adjacent table.

Center for Marine Conservation's recommendations for future actions on ecosystem-based management in the Bering Sea.

- support for efforts to incorporate Native, local, and fishers' knowledge in research and management;
- increased communication and cooperation with Russian scientists, Natives, and managers;
- additional effort to identify sources of existing information to: 1) identify significant data gaps; and 2) facilitate retrospective synthetic analysis;
- collaborative identification of "hot spots" for cooperative, cross-discipline research, which should then become a high priority for funding agencies;
- expansion of the North Pacific Fishery Management Council's (NPFMC) efforts to consider the ecosystem effects of fishery management;
- National Marine Fisheries Service's (NMFS) publication of Supplemental Environmental Impact Statements for both Alaska Groundfish Fishery Management Plans;
- NMFS reinitiation of consultation under the Endangered Species Act regarding endangered Steller sea lions and commercial fisheries;
- NPFMC support of the development of an experimental regime for dispersing the pollock fishery in time and space in the Aleutian Islands region;
- NPFMC consideration of the establishment of marine reserves, restrictions on the use of destructive gear, and other mechanisms to protect areas of high productivity, important habitats, and other sites;
- creation of a working group to investigate ways to increase the diversity of forage fish in important marine mammal and sea bird foraging areas;
- NPFMC exploration of mechanisms to move away from single species management and to diversify fishing technology;
- establishment of a multi-disciplinary, cross-sector team to establish common goals for long-term management of the Bering Sea ecosystem, and mechanisms for achieving those goals.
- conclusion of a Russian-United States international agreement for collaborative research and management that will promote conservation of the resources in the Bering Sea.

Alaska Groundfish Supplemental Environmental Impact Statement

Summary by Tamra Faris and Loh-lee Low

NMFS released for public review a draft supplemental environmental impact statement (SEIS) for the Fishery Management Plans (FMPs) for the Bering Sea and Aleutian Islands Groundfish Fishery and the Gulf of Alaska Groundfish Fishery. The purpose is to update the original EISs prepared when the FMPs were first approved (1976 and 1981) and renew the federal action of groundfish management in the Alaska EEZ into compliance with the National Environmental Policy Act.

The draft SEIS analyzes the impacts of fishing over a range of TAC specifications and compares them to impacts of status quo fishing. NEPA guidelines require consideration of several, or a range of, alternatives, in addition to the proposed action. Alternatives are evaluated to show the range of viable options and their impacts to the environment. The measurable impacts of an alternative TAC specification would accrue to the target resources themselves, other species in the ecosystem, and those that benefit both from consumptive and non-consumptive users of living marine resources. During the scoping phase for this SEIS, it was determined the public envisioned more ecosystem-based approaches to setting species TACs than are manifest in the present system. Concepts of ecosystem-based management are incorporated in present management and are components of all the alternatives. Knowledge and understanding of North Pacific Ocean and Bering Sea ecosystems are, never-the-less, recognizably incomplete.

In developing alternatives for purposes of analysis, fishery management regulations in place and mechanisms available to modify regulations are assumed to remain available and apply consistently over the range of alternatives. The alternatives analyzed include:

Alternative A -- The no action alternative whereby TACs are specified under the status quo. Under status quo, TACs are set by species or species groups for each groundfish complex, and the sum of the TACs of the component species must stay within the optimum yield (OY) range of the complex. The OY range for the BSAI groundfish complex is 1.4 to 2.0 million metric tons (mt), and that for the GOA is 116,000 to 800,000 mt. Under this alternative, TAC projections are made from 1999 through 2002 for the purpose of demonstrating potential fishery impacts. In actuality, re-setting of TACs each year will be based upon the status of the stocks current for that year.

Alternative B -- Under this alternative, the sum of the TACs for the groundfish complex was set at the lower end of the OY range. Each TAC was decreased proportionately from its 1997 level to generate the TACs for this alternative. The sums of the 1997 TACs for the BSAI and GOA, respectively, were 2.0 million mt and 282,815 mt. Therefore, each BSAI TAC was set at 70 percent of its 1997 level and each GOA TAC was set at 41 percent of its 1997 level in order to have TACs that summed to 1.4 million mt and 116,000 mt for the BSAI and GOA, respectively. Under this alternative, each species' TAC would be held constant for fishing years 1999 through 2002.

Alternative C -- Under this alternative, the sum of the TACs for the groundfish complex was set at the upper end of the OY range. The sum of BSAI TACs in 1997 was 2.0 million mt; therefore, the BSAI TACs for Alternative C were set equal to their 1997 levels. This was not the case for the GOA because the 1997 GOA TACs summed to much less than the upper end of the OY range. The 1998 overfishing levels (OFLs) were used to set the GOA TACs for Alternative C. The upper end of the GOA OY range is 800,000 mt and the sum of the 1998 OFLs is 817,620 mt; therefore each TAC was set equal to 97.8 percent of the OFL for that species. Under this alternative, each species' TAC would be held constant for fishing years 1999 through 2002.

Alternative D -- This alternative assumes no directed groundfish fisheries in the Exclusive Economic Zone (EEZ) off Alaska beginning in fishing year 1999. The TACs are set at zero under Alternative D from fishing years 1999 through 2002.

ESA Species listed under the Endangered Species Act (ESA) are present in the action area and some are negatively affected by the SEIS subject federal activity, fishing. NMFS is the expert agency for ESA listed marine mammals. The USFWS is the expert agency for ESA listed seabirds. The proposed action, continuation of the federal groundfish fisheries in the EEZ off Alaska, must be in compliance with the ESA. To determine compliance with ESA, Section 7 Consultation under the ESA has been renewed with the NMFS for listed marine mammals and the USFWS for Short-tailed Albatross. NMFS Section 7 Consultation is focusing particular attention on stock assessment and TAC-setting, and the resulting conduct of the fisheries. It is expected to be completed in January, 1999, with a Biological Opinion. The USFWS Section 7 Consultation is focusing particular attention on direct takes of Short-tailed Albatross by longline fishing gear. It is expected to be completed in December, 1998.

Groundfish analysis is facilitated by a 5-year simulation of the age structure and population dynamics of the major groundfish stocks. The model projects biomass and catch for 10 stocks based on assumptions of reasonable levels of future recruitment and stock trend. The simulation was designed to emulate the TAC setting as it occurs under Alternative A. The model results provide a more rigid scenario than would be used by the decision process of the Council. The model outputs consisted of projected values of several variables for each stock, alternative, simulation, and year. These variables included total biomass (the biomass of fish in the entire age range covered in the respective stock assessment), spawning biomass (the biomass of mature females), population age structure (numbers of fish at each age covered in the respective stock assessment), and catch. Because the projections were stochastic, the results consisted of statistical distributions rather than single point estimates, thus enabling impacts of the alternatives to be described probabilistically. When the impacts could not be quantified, a qualitative discussion is provided. While it is known that harvesting activities impact the stocks, it is difficult to determine the exact linkages and the magnitude of the impacts given all other factors.

The modeling simulations demonstrated that, on average, most stocks that are commercially fished are expected to increase under all alternatives. In most cases, broad confidence intervals were observed around ending biomass projections due to potential differences in recruitment. For the most part, it can be said that the status and trend of the groundfish stocks are largely driven by naturally occurring recruitment variations. Predictions of the impacts under the alternatives are difficult due to unknown future recruitment.

Alternative A, the no action alternative, is used as the baseline to compare environmental impacts of fishing at higher and lower TACs. Alternative A requires determination of acceptable biological catch (ABC), OFL, and TAC of the target species. The TAC specifications are set in a risk averse manner. Annual TACs are set at or below ABC and are considerably lower than the associated OFLs. In some cases, the TAC specifications established are substantially below the ABC levels for bycatch or OY considerations, or because of uncertainty in stock assessments. As an added precaution, the ABC/OFL guidelines call for a reduction in fishing mortality rates whenever stock size falls below a target level. Setting TAC specifications so that the sum of the TACs equals the low end of the OY range (Alternative B) further reduces the chance of setting the harvest levels at levels that lead to overfishing. Conversely, it is thought that setting TACs to equal the upper end of the OY range (Alternative C) could impose more risk to some stocks. Alternative D would be to reduce the TACs to zero, resulting in no directed groundfish fisheries in the EEZ. The primary impact would be to eliminate the risk of overfishing in the EEZ. Increases in catches of groundfish in adjacent areas (Alaska State waters and international waters) could be anticipated.

Other environmental impacts associated with groundfish harvest go beyond those ascribed to the TAC and ABC specifications. Changes in TAC may result in changes in food availability to predators of groundfish or changes in natural mortality rates of groundfish prey. Major changes due to shifts in community structure are not expected under Alternative A. Evidence suggests little impact of any of the alternatives on species diversity. Impacts to forage fish under all the alternatives is expected to occur directly through bycatch mortality in groundfish fisheries and indirectly through food chain interactions. Analysis of bycatch estimates under all the alternatives indicated low bycatch mortality relative to other sources of mortality, particularly mortality due to predation by groundfish species. Although the actual amounts of change in forage fish abundances that would occur through the food chain interactions in the various alternatives are not well-known, it is likely that alternatives which reduce TACs of abundant groundfish such as pollock and arrowtooth flounder that prey on forage species would tend to reduce forage fish abundance.

Prohibited species were fully utilized species before the growth of the domestic groundfish fisheries. The prohibited species (i.e., Pacific halibut, all five Pacific salmon species, steelhead, Alaska king crab, Tanner and snow crabs, and Pacific herring) must be returned to the sea when taken by the groundfish fisheries. The main direct impact of groundfish fisheries on the prohibited species has been through bycatch. Bycatch reduces the potential yield and changes the population characteristics of the resources and reduces the amount of target catch for those fisheries. Another impact is ecological, whereby the residual groundfish and prohibited species would compete ecologically for food and space. The control of bycatch has been through prohibited species catch limits (PSC caps) set by regulations. It was assumed PSC caps would remain at current levels with the exception of Alternative C for the GOA. Projected bycatch amounts of each prohibited species were based upon the bycatch rates in 1997 and projected catch target fishery. Thus, projected bycatch would be lower as groundfish TACs decrease (Alternative B and D) and higher when they increase (Alternative C).

For the BSAI region, bycatch of all PSC species would be lowered from Alternative A to Alternative B. Bycatch amounts would also not increase appreciably in the BSAI area under Alternative C because the TACs of the BSAI target species under Alternative C are equal to or close to the TACs of Alternative A. For the GOA region, bycatch amounts have been projected to increase substantially for Pacific halibut, *C. bairdi* and *C. opilio*, and Pacific salmon under Alternative C because groundfish TACs in the GOA would increase substantially from Alternative A. The projected increase in groundfish catch and PSC bycatch could only occur if the Pacific halibut PSC limit were increased substantially, i.e., to 14,200 mt. Bycatch amounts would be zero in Federal waters under Alternative D. It is unknown to what extent catch and bycatch in adjacent areas (Alaska State waters and international waters) would increase as result of closure of the groundfish EEZ fisheries.

Habitat and natural community alterations are inevitable when harvesting marine organisms with any gear type. The disturbances caused by fishing gear to the various substrates and benthic communities, however, are difficult to quantify and predict. The direct impacts of such disturbances can vary substantially depending upon the particular combinations of fishing intensity, distribution, and harvesting methods that are employed. As a first step to assessing such impacts, an analysis was conducted to estimate the potential amount of fishing effort expended under the four alternatives. Using sampled hauls from the domestic observer database (1990 to 1997) and simple linear regression, a functional relationship between catch and effort was established by target fishery and gear type. Given estimates of the expected catches under the four alternatives, corresponding effort levels were determined. While the results of this analysis do not directly address the impacts of fishing effort on the substrates and benthic communities, they do provide a means for making quantitative comparisons of fishing effort by target fishery and gear type. General inferences were made regarding the relative impacts of the different effort levels on the substrates and benthic communities.

Marine Mammals are important top predators in the marine ecosystem in waters off Alaska. Currently, NMFS and the FWS manage 25 species that comprise 39 stocks in waters off Alaska. Population sizes range from less than 200 individuals (e.g., eastern North Pacific stock of "transient" killer whales) to over one million individuals (e.g., northern fur seals). Nine of the 39 stocks are listed as endangered under the Endangered Species Act, while one stock is listed as threatened. In addition, one stock is listed as depleted under the Marine Mammal Protection Act.

Marine mammal impact evaluations are based on interpretation of two main types of interactions with commercial fisheries: direct (operational) and indirect (biological). Mortality resulting from entanglement in fishing gear, or incidental take, represents a direct interaction. In all cases in the Federal groundfish fisheries off Alaska, levels of direct incidental take are low relative to each marine mammal stock's Potential Biological Removal (PBR).

Indirect interactions between marine mammals and commercial fisheries are much more difficult to detect. They include: a) competition for similar prey resources which may result in local scarcity of prey and b) disturbance by fishing activities. The mechanisms by which fish biomass removals might translate to marine mammal fitness or mortality are largely unknown. However, in this discussion of impacts, a risk averse approach is used. It assumes that the harvest of groundfish stocks that are important prey items in the diet of certain marine mammals may result in increased competition with that marine mammal stock. This, in turn, may have adverse impacts on those marine mammal populations, particularly where the competition involves primary prey items (e.g., the top 2 or 3 species consumed), and where fishing activity occurs in known, or likely, marine mammal foraging areas.

Interactions, either direct or indirect, between commercial fisheries and the 26 species of marine mammals inhabiting Alaskan waters vary widely, given those species' diverse life histories and spatial distribution patterns. Of the 26 marine mammal species in Alaska described in Section 3.4, only a subset have been shown to consume groundfish species as a large part of their diet, and to potentially do so in areas coincident with groundfish harvest operations: Steller sea lion, northern fur seal and harbor seal. Based on the potential for indirect interactions, Alternatives A, B, and C may have adverse impacts on the western stock of Steller sea lions, northern fur seals in the Bering Sea, and both the GOA and western stocks of harbor seals. Alternative D could also pose adverse impacts because State-managed fisheries (inside 3-miles) would continue to target marine mammal forage species in their foraging areas, would continue to be a source of fishing activity disturbance, and would probably expand in the absence of groundfish fisheries in the EEZ. The relative severity of any such impacts resulting from the alternatives is highest for the western stock of Steller sea lions, followed by northern fur seals, the GOA stock of harbor seals, and the western stock of harbor seals.

Seabirds are top predators in the marine ecosystem and obtain almost all their food at sea. Prey include small fish, zooplankton, and other invertebrates. Each seabird species depends on one or 2 species of prey in each area. Fifty million seabirds of 38 species breed in Alaska, and another 30 million birds of 5 species visit during summer. Population trends are known for about one-third of Alaskan seabirds; trends vary among species and areas. One seabird, the short-tailed albatross, is listed as endangered.

Potential impacts of groundfish fisheries on seabirds include (a) changes in food resources and their availability, (b) bycatch in fishing gear, (c) discards and processing wastes, and (d) accidents such as oil spills or the escape of rats from fishing vessels onto nesting islands. Impacts to food supplies have the greatest potential to affect Alaskan seabird populations.

The impact of groundfish fisheries on seabird food resources (potentially the most important) are unknown for all alternatives, because too little is presently known about the ecology of seabird forage species, food-web interactions, and factors that determine availability of food to seabirds. Little or no change in most bycatch of seabirds, levels of discards and wastes, or in the risk of oil spills or rat invasions is expected over the period 1999 to 2002 under Alternative A. A slight increase in bycatch of sooty shearwaters and auks might occur over 1997 levels during the period 1999 to 2002 under Alternative A. Alternative B seems also likely to have little impact on bycatch of seabirds in the BSAI, except for effecting a slight decline for shearwaters and auks. In the GOA, Alternative B may cause a slight to moderate decline in the bycatch of seabirds. In both the BSAI and GOA, a slight to moderate decrease in risk of oil spills and rat invasions might attend Alternative B. Alternative C would potentially cause a slight to major increase in seabird bycatch, and also in oil spills and rat invasions. While present information is insufficient for analysis of impacts on seabird food resources, projections for Alternative D suggest a major decrease in the probability of other fishery associated impacts on seabirds.

The impacts of Alternatives A, B, C, and D on the food supply of seabirds could not be evaluated because crucial information is lacking. Little is known about the ecology of seabird forage species, food-web interactions between them, and factors that determine availability of food to the birds. The effects of trends in walleye pollock on seabirds could not be predicted. Seabirds eat age 0 and age 1 pollock, the portion of pollock's population dynamics least well known; the effects of stock changes on local forage densities near seabird colonies are not known; and other species are more important for seabirds in many areas of Alaska. Major forage species such as capelin, sand lance, myctophids, and zooplankton have been studied very little in Alaska. In addition, food availability to seabirds is determined by oceanographic factors, both local and regional, but it is unknown how oceanography and fishery management may interact to change the food supply of seabirds.

Socio-economic implications of the alternatives are evaluated from projections of the following:

(1) groundfish catch, (2) groundfish discards, (3) prohibited species bycatch, (4) the bycatch of other non-groundfish species, (5) ex-vessel value, and (6) processed product value. These physical and monetary measures of output from the BSAI and GOA groundfish fisheries provide indirect measures of the employment, income, and consumer benefits associated with the commercial groundfish fisheries under each alternative.

Finally, the Draft SEIS provides other background information on the resources, their environment, and further details that would be useful for evaluating the impacts of fisheries that could be conducted under each of the Alternatives. Copies of the SEIS are available from the NMFS Alaska Region.

Proposed Future Direction of the Ecosystem Considerations Chapter

by Pat Livingston

Here are some ideas about expanding and standardizing some of the content of the Ecosystems Consideration Chapter to more clearly highlight the status of ecosystem-based management efforts and the status and trends of various parts of the ecosystem. These changes and additions would accomplish several goals:

1) track ecosystem management efforts and their efficacy
2) track changes in the ecosystem that are not easily incorporated into single-species assessments
3) bring results from ecosystem research efforts to the attention of stock assessment scientists and fishery managers
4) provide a stronger link between ecosystem research at AFSC (and elsewhere) and fishery management

Below is an expanded outline of two main sections that would highlight ecosystem management efforts and ecosystem status and trends. Some of the proposed time series are not yet readily available and may take some effort to develop while others will be available for next year's document. As the document evolves, other time series may be developed and added to this chapter. Scientists from Alaska Fisheries Science Center, other NOAA components such as PMEL and NOS, North Pacific Fisheries Management Council, Alaska Department of Fish and Game, U.S. Department of the Interior, University of Alaska, and others will be contacted in 1999 and encouraged to provide key time series outlined on the following two pages and a brief description and interpretation of the time series data. Hopefully, over the next two to three years most of the time series shown in the outline will be available and can be updated easily on an annual basis. The plan teams would still need to develop their ecosystem concerns and research recommendations based on this and other information they receive.

I. ECOSYSTEM MANAGEMENT INDICES

Purpose: To provide measures of performance towards meeting the stated ecosystem management goals of the NPFMC. These goals are to:

1. Maintain biodiversity consistent with natural evolutionary and ecological processes, including dynamic change and variability.
2. Maintain and restore habitats essential for fish and their prey.
3. Maintain system sustainability and sustainable yields for human consumption and non-extractive uses.
4. Maintain the concept that humans are components of the ecosystem.

Some ecosystem management indices could be measuring progress in more than one of these goals. Diversity, in particular, could be considered a broad, overarching goal and the others are more specific ways of protecting diversity. Sub-goals under diversity could include: protect and restore EFH, protect critical habitat of protected species, and reduce bycatch. However, given the goals as stated by NPFMC, here is an initial attempt at organizing some indices by ecosystem management goal.

A. Maintain diversity

1. Time series of bycatch/discard amounts of prohibited species and non-target species and fish processing wastes in the EBS, AI, and GOA

2. Time series of amount of closed area and duration of time various species (salmon, herring, snow crab) are protected from groundfish capture fisheries
3. Time series of directed salmon and crab catch, salmon hatchery production by nation

B. Fish habitat protection

1. Time series of the amount of area closed to bottom trawling in the EBS, AI, and GOA
2. Time series of amount of groundfish fishing effort by gear type in the EBS, AI, and GOA (segregated by inshore, offshore, and slope regions if possible)
3. Time series of state fishery closures (scallop, crab, salmon)

C. Sustainability (for consumptive and non-consumptive uses)

1. Time series of trophic level of the catch and total amount of groundfish catch (relative to total exploitable biomass) by region
2. Table summarizing status of managed groundfish, crab, and salmon species (# stocks below target stock size, # above target stock size, # unknown). Any success measures of rebuilding programs?
3. Time series of amount of catch of protected species' prey inside critical habitat
4. Time series of exploitation rates by specific time/area units for fisheries with time/area quotas

D. Humans are part of ecosystems

1. Number and efficacy of limited entry, licence, ITQ systems , changes in fishing power and fleet composition of groundfish, crab, salmon, scallop fisheries
2. Coordination of activities with other organizations

<u>II. ECOSYSTEM STATUS INDICATORS</u>

A. Physical environment

1. Time series of the Pacific Decadal Oscillation Index (PDO)
2. Time series of summer surface and bottom temperatures and the magnitude of the Bering Sea cold pool from AFSC bottom trawl survey data
3. Time series of ice extent index - EBS
4. Time series of amount of freshwater inputs - GOA

B. Habitat

1. Indices of pollutant/contaminant levels in sediments, groundfish, and their prey
2. Summaries of bottom habitat composition by region

C. Living Marine Resources

<u>Phytoplankton and zooplankton</u>

1. Abundance trends of phytoplankton and zooplankton in GOA and EBS

<u>Forage Fish</u>

1. Abundance trends of capelin in GOA (Pavlov Bay)
2. Forage species (as defined in the forage fish amendment) abundance trends in EBS
3. Forage abundance and diversity trends inside protected species' critical habitat
4. Other forage species' abundance and trends (herring, juv. plk)

<u>Benthic Invertebrates</u>

1. Abundance and diversity trends of benthic macroinvertebrate groups, including crab, captured in NMFS bottom trawl surveys - EBS
2. Epifauna abundance and diversity trends inside and outside protected areas
3. Abundance and diversity trends of benthic macroinvertebrate groups captured in NMFS bottom trawl surveys GOA

Non-target fish species

1. Abundance and diversity trends of non-target species in the EBS
2. Abundance and diversity trends of non-target species in the GOA and AI

Marine Mammals

1. Status and diversity trends of northern fur seals, Steller sea lions, and harbor seals
2. Status and trends of other seals and cetaceans
3. Net debris entanglement indices for northern fur seals

Seabirds

1. Status and diversity trends of seabirds

Ecosystem or community indicators

1. Diversity trends of groups sampled by NMFS bottom trawl surveys
2. Trophic level trends of groups sampled by NMFS bottom trawl surveys
3. Size diversity trends of groups sampled by NMFS bottom trawl surveys

Recent Meetings, Symposia, and Publications Relating to Ecosystem-based Management

There are numerous indications that others besides the North Pacific Fishery Management Council family have noticed and are reacting to apparent changes and concerns about the North Pacific. A compilation of new legislation, meetings and publications is provided below. The list is likely not all inclusive.

- The North Pacific Fishery Management Council's Ecosystem Committee met several times to advise the Council on ecosystems level forces applying to fishery management in the federal waters off Alaska.
- The United Nations declared 1998 as *International Year of the Oceans* early in 1997. NOAA is expected to take a lead role.
- The final draft of a paper, *Bering Sea Ecosystem--A Call to Action*, was released by the Department of the Interior September 1998.
- The National Academy of Sciences appointed the NMFS Ecosystem Principles Advisory Panel to work on a report to Congress on *Uses of Ecosystem Approaches in Fisheries Management*. Their first meeting was in September 1997. The report is due in 1998.
- The Center for Marine Conservation (non-governmental organization) sponsored a *Bering Sea Ecosystem Workshop* for representatives from academia, natural resource management agencies, Alaska Natives organizations, and the environmental community to identify and discuss ecosystem-based management issues on Oct. 5-7, 1997, in Anchorage.
- The Conservation Law Foundation produced the proceedings of a conference on the *Effects of Fishing Gear on the Sea Floor of New England.*
- The proceedings of the 1996 Lowell Wakefield Symposium *Forage Fish in Marine Ecosystems* was published by the University of Alaska Sea Grant College Program. Report No. 97-01.
- Sea Grant published a paper by D. Alverson, *Discarding Practices and Unobserved Fishing Mortality in Marine Fisheries: An Update.*
- A Lowell Wakefield Fisheries Symposium on *Incorporating Ecosystem Considerations into Fisheries Management* was held September 29-October 3, 1998, in Anchorage.
- The National Marine Fisheries Service and Department of Interior are co-chairing the *Bering Sea Ecosystem Workshop*, to inventory the existence and availability of resource databases on Dec. 4-5, 1997, and again on June 2-3 in Anchorage.

ESSENTIAL FISH HABITAT

by Jeff Fujioka

INTRODUCTION

In 1996, the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act to require fishery management plans (FMPs) to describe and identify essential fish habitat (EFH), adverse impacts on EFH, and actions to conserve and enhance EFH. Guidelines were developed by the National Marine Fisheries Service (NMFS) to assist Fishery Management Councils (Councils) in fulfilling the requirements set forth by the Act. In addition, the Act requires consultation between the Secretary and Federal and state agencies on activities that may adversely impact EFH for those species managed under the Act. It also requires the Federal action agency to respond to comments and recommendations made by the Secretary and Councils.

After reviewing the best available scientific information, and in cooperation with the Councils, participants in the fishery, other agencies, and other interested parties, NMFS was to develop written recommendations for the identification of EFH for each FMP. Prior to submitting a written EFH identification recommendation to the Council for an FMP, the draft recommendation was made available for public review and at least one public meeting was held. NMFS worked with the Council to conduct this review. After receiving public comment, NMFS revised its draft recommendations, as appropriate, and forwarded written recommendation and comments to the Council(s).

An Alaska Region EFH Core Team was designated to coordinate efforts to accomplish the necessary tasks. The Core Team initiated preliminary Essential Fish Habitat Assessment Reports, summarizing available environmental and fishery data sources relevant to the managed species that would be useful in describing and identifying its EFH. This was accomplished by identifying Technical Teams for the Groundfish, Crab, Scallop, and Salmon FMP's from Core Team members and experts from NMFS and ADF&G. Synopses from representative species were provided by respective experts from AFSC and ADF&G. These reports summarized what was known about each species biology and distribution by major life stage. They also helped to identify major species-specific habitat data gaps, which are prevalent in Alaska. In addition to identifying existing literature and reports relevant to identifying EFH, a report was produced summarizing distribution data on major groundfish and bycatch species in the groundfish observer database (Fritz, Greig, and Reuter 1998).

DESCRIPTION AND IDENTIFICATION OF EFH

Utilizing the compiled information the Core Team and Technical Teams drafted descriptions and identifications of EFH, following the NMFS guidelines for the most part. The guidelines indicated that a tiered approach be used to gather and organize the data necessary for identifying EFH. In Alaska, there are many species life stages, other than the freshwater stages of salmon and exploitable stages of groundfish, for which the information level is less than the lowest level conceived by the NMFS guidelines - level 1, ability to establish presence/absence distributions. Alaska scientists, having pointed this out in early reviews of the guidelines, used a level 0 in summarizing knowledge levels for many species life stages in the EFH identifications and descriptions. Level 0 designates the subset of level 1 for which data is not available to establish presence/absence distributions. This was the most prevalent designation for pre-adult stages of marine species, such as groundfish and scallops. The descriptions and identifications of EFH for groundfish, crab, scallops, and salmon FMPs are provided in the EA/RIR for amending the appropriate FMPs.

In June 1998, the Council adopted plan amendments for the five FMPs (BSAI and GOA groundfish, salmon, crab, and scallops) to incorporate EFH provisions. These provisions included identification and description of EFH including habitat areas of particular concern, identification of research and information needs, and identification of potential adverse effects on EFH due to fishing and non-fishing activities. The Council adopted Alternative 2, that designates EFH as described by general distribution.

RESEARCH NEEDS

The guidelines indicated that each FMP should contain recommendations, preferably in priority order, for research efforts that the Councils and NMFS view as necessary for carrying out their EFH management mandate. The need for additional research is to make available sufficient information to support a higher level of description and identification of EFH, evaluate potential adverse impacts, and measures to conserve EFH. The Core Team drafted text addressing research needs are contained in the EA/RIR.

The EFH Core Team was also tasked with advising the Region on project proposals and spending plans for EFH funds. With the goal of rationalizing the development of spending plans and proposal evaluation, the Core Team drafted a framework for categorizing Groundfish and Salmon EFH activities. The framework concept was to identify activities and objectives that progress in a logical manner toward the goal of assuring sufficient habitat to sustain fisheries. For e.g., for groundfish, where for most species little is known about life history, or even where early life stages reside, it was obvious to the Team that gaining knowledge of life history phases that are vulnerable to habitat alterations deserved emphasis. For salmon, where much of the critical freshwater life history phase and it's habitat requirements are identified, it was recognized that emphasis could progress to improving management and awareness of activities that adversely impact critical habitat or to restoration of habitat that has already been impaired. The effects of fishing on habitat also stands out as a priority concern. Recognizing its responsibility as the action agency for fishing activity in the EEZ, NMFS/AK has been supporting research in Alaska on the effects of fishing on seafloor habitat since 1996. These activities are reported on in the Effects of Fishing chapter of this volume.

Based on the strategic framework and review of the EFH identification results the Core Team drafted a spending plan recommendation for EFH funds allocated to the AK Region from Habitat Office headquarters. In addition to funds needed to supplement the administration of EFH amendments to the FMPs, the spending plan identified three projects to improve the consultative and management process:

1. Development of consultative requirements.
2. Evaluate GIS
3. Develop a Logging Road GIS

and four research projects to improve knowledge on the vulnerability of species life stages to habitat alterations.

4. Development Impacts on Eelgrass Habitat
5. Nearshore Habitat Utilization by Juvenile Groundfish
6. Identification and Characterization of Atka mackerel Reproductive Habitat
7. Habitat Utilization of Urban Estuarine Wetlands

These projects were funded with FY98 EFH funds allocated to the Alaska Region. A report on objectives and activities of these projects follow.

EFH PROJECTS REPORTS:

1. PROJECT: Development of Consultation Requirements/MOU's
Principal Investigator - Jeanne Hanson (NMFS Alaska Region - Anchorage)

Funding was available for a contract with Alaska Department of Fish and Game (or another government agency or private consultant) for help in developing consultation protocols and memorandums of understanding (for anadromous fish consultations and other EFH consultations). Because of delay in direction in how to proceed with consultations this money was carried over to be spent in FY 99 for the same purpose.

2. PROJECT: Evaluate GIS
Principal Investigator - Linda Show (NMFS Alaska Region - Juneau)

There were two parts of this project:

a.) Essential Fish Habitat Digital Mapping Project

The SFA requires a Federal action agency to respond to comments and recommendations made by the NMFS and Councils. The NMFS guidelines propose ultimate use of Geographic Information Systems (GIS) to analyze and present mapping of general distribution and geographic limits of EFH for each life history stage in FMPs. The guidelines also suggest the use of GIS to analyze and present mapping of adverse impacts. The Alaska Region will be responsible for development of an adverse impacts database to be used with maps of general EFH characteristics. These maps are also needed for reference and for public information dissemination through a web site. Currently the Alaska Region has GIS software and hardware but has not developed an adverse impacts database. A GIS-user interface to access and analyze such information has been developed and is being evaluated as a prototype. These products will have to be closely coordinated with maps produced for viewing EFH.

The Alaska Region contracted with Resources Data Inc. of Anchorage, Alaska to provide digitized maps, usable in ArcView software, of seventy-two top priority maps identified by Regional personnel. Mapping has begun and is expected to be completed by January 1, 1999. The final product will be supplied on CD copies, to both the Anchorage and Juneau Habitat offices, and will be compatible with the GIS-user interface .

b) Essential Fish Habitat Digital Mapping Project Consultative Services.

The Alaska Region contracted with Resources Data Inc. of Anchorage, Alaska to provide consultative services in concert with the above mapping project. As part of the consultative service, a sampling of completed maps are to be demonstrated to regional staff at a November 12 & 13, 1998 EFH retreat in Juneau, Alaska. This will allow review of the maps and an opportunity to discuss their development. One issue will be choosing a projection to allow overlay of the maps on NOAA charts.

3. PROJECT: Logging Road GIS for Salmon EFH on the Kenai Peninsula
Principal Investigator - Michael Murphy (NMFS Alaska Fisheries Science Center - Auke Bay Lab)

Project Cooperators are Alaska Department of Fish and Game and National Marine Fisheries Service, with road access granted by Cook Inlet Region, Inc., and Ninilchik Native Association.

The objectives of this project are to inventory and assess the operational effectiveness of stream crossing structures (e.g., culverts and bridges) on logging roads, the degree of compliance with ADF&G Fish Habitat Permit stipulations and forestry best management practices (BMPs), and to develop a geographic information system (GIS) to track condition of crossing structures for maintenance or retro-fitting. The start of this project underwent several delays related to interagency funds transfer, personnel hiring, and obtaining necessary land use permits to access private lands.

A detailed draft operational plan was written that describes methods and field procedures for data collection for each parameter, the level of precision for individual measurements, valid data values and measurement units. Based on field efforts to date, some procedures were adjusted and refined, and these will be reflected in the final version of the plan.

At this time, data collection has been completed, including digital photographs and differential GPS locations, for 20 crossing structures located on both state and private Native corporation lands. Approximately 60% of these structures are located on private lands. We have not collected a sufficient amount of data to develop any preliminary impressions or conclusions. Field work will continue until streams freeze. At that time, data entry and framework development for the GIS portion of the project will begin. Although some minor timing setbacks have been encountered, the project is on schedule to complete on or before September 30, 2000.

4. PROJECT: Urban Development-Related Impacts on Eelgrass Habitat
Principal Investigator - Michael Murphy (NMFS Alaska Fisheries Science Center - Auke Bay Lab)

Objectives of this project are to (1) determine the role of eelgrass beds as essential fish habitat; (2) assess cumulative effects of 404 Permit filling in the vicinity of Craig, Alaska; and (3) provide an updated GIS maps of existing eelgrass and other estuarine habitats near Craig.

The seasonal role of eelgrass was examined by seining eelgrass and adjacent non-eelgrass sites in April, May, June, and September. A paired-site design was used to compare eelgrass habitat with adjacent non-eelgrass habitat. Four site pairs were established from inside Klawock Inlet to its opening at Bucarelli Bay. We used a 37-m-long, variable-mesh beach seine to capture fish and decapods at two adjacent beaches (>50 m apart) at each site. All sampling occurred during low spring tides (<0 m elevation). Based on observations of a diver, seining was more than 95% efficient. Captured fish and decapods were identified to species and enumerated, and a sample of target species, including salmonids, flatfish, gadids, and rockfish (*Sebastes* spp.), were measured for length. Sites were classified by habitat type (Dethier 1990), and physical data (e.g., temperature, salinity, substrate composition, depth profile) were also taken. Vegetation cover was estimated each sampling date, and eelgrass was sampled in quadrats to determine seasonal density, height, and biomass.

Preliminary results indicate that eelgrass habitat had higher total fish density and species diversity than non-eelgrass habitat. Eelgrass appeared to be important nursery habitat for chum salmon fry in April, and chum fry moved away from eelgrass in May and June. Other salmonids (pink salmon fry, coho smolts) were not significantly associated with eelgrass habitat. Juvenile rockfish (*Sebastes* spp.) were more abundant in vegetated habitats, both in eelgrass and *Laminaria* beds.

Cumulative effects of the 404 permitting program are being assessed by inventorying existing eelgrass beds and areas already filled in the vicinity of Craig and Klawock. The habitat inventory was contracted to the

U.S. Fish and Wildlife Service to update the existing National Wetlands Inventory (NWI) database (which currently depicts no eelgrass at all in the vicinity). The USFWS flew the area 2 days in August at low spring tides and reclassified the shoreline. The City of Craig also hired an independent contractor with City funds and a grant from the State of Alaska to map all eelgrass beds within the Craig city limits. With these data and information on previous permitted fills, we will evaluate cumulative effects by calculating the proportion of eelgrass beds that have been lost due to filling.

The last objective of this project is to provide updated GIS maps of shoreline habitats near Craig. The contract with the USFWS was to update all shoreline in the USGS quadrangles Craig B4, Craig C4, and the Trocadero Bay portion of Craig B3. Field verification was completed in August for all shoreline, except for part of Craig B4 (Waterfall to Big Bay). The GIS files (digitized maps) for Craig B3 will be available in January 1999, and files for Craig C4 will be completed in March 1999. Field verification for Craig B4 will be completed in spring 1999, and GIS files available in October 1999.

5. PROJECT: Nearshore Habitat Utilization by Juvenile Groundfish
Principal Investigators - Michael Murphy and Scott Johnson (NMFS Alaska Fisheries Science Center - Auke Bay Lab)

Out of necessity, groundfish sampling has been predominantly on adult fish to obtain knowledge for fishery management, mostly on the continental shelf and slope. Due to the remoteness of most of Alaska's coastline, very little sampling has occurred in nearshore habitats where many species spend part of their early life history. The objective of this study in 1998 was to develop effective sampling methods for juvenile groundfish in a range of nearshore habitats in Southeast Alaska. In 1998, various sampling gear (e.g., traps and seines) were tested in combination with an underwater video system to evaluate sampling methods for capturing groundfish and for quantifying habitat structure.

In April, 1998, the NOAA vessel *John N. Cobb* was used as a platform in several bays near Sitka to test an underwater video-sled being developed by scientists with RACE Division. Designed for offshore deeper waters, this system was not well suited for sampling fish in nearshore habitats. Based on this test, it was decided to purchase a remotely controlled vehicle (ROV) which allows close control and live video feedback. In August, a second, 2-week cruise on the *Cobb* was used to test the ROV in 10 bays comprising a transect across Southeast Alaska from Biorka Island off Sitka to Funter Bay near Juneau. Traps and seines were also used in conjunction with the video on both *Cobb* cruises.

The ROV proved effective to video juvenile groundfish and their habitat at depths to at least 70 m and in moderate current. The ROV was used in different habitat types including eelgrass, kelp forests, *Laminaria* beds, and rock cliffs. The ROV was operated out of a skiff, powered by a portable generator, and controlled by a console in the skiff. Preliminary results show that 1) the ROV works best for epibenthic fish and not as well for pelagic fish; 2) most fish were not disturbed by the ROV; and 3)the ROV was more effective than other types of sampling (e.g., trapping, seining, or divers). Video from the ROV also revealed that species abundance and diversity declined sharply from outside waters near Sitka to inside waters near Juneau. Future studies with the ROV will focus on quantifying fish abundance and habitat characteristics in a wider geographic area.

6. PROJECT: Identification and Characterization of Atka mackerel (*Pleurogrammus monopterygius*) Reproductive Habitat.
Principal Investigators - Lowell Fritz, Bob Lauth, Scott McEntire (NMFS Alaska Fisheries Science Center - Seattle)

The primary objectives of this research project were to locate and describe one or more Atka mackerel nesting areas in the eastern Aleutian Islands. Habitat was to be described in terms of bottom type, vegetation, vertical temperature and salinity profiles, and, if possible, surface and bottom currents. Attempts were to have been made to estimate the number of nests, to map their distribution within the area, to characterize male territory size and behavior, and to estimate the potential productivity of the area. An area near Dutch Harbor, AK was chosen for this initial project because Atka mackerel are known to aggregate on Chelan Bank north of Dutch Harbor. It was thought that some mature individuals from this aggregation may come inshore to spawn in mid-late summer.

An initial trip was conducted to scout potential spawning/nesting sites and locate aggregations of male Atka mackerel using an underwater camera. A one-day charter was arranged aboard the F/V Katie Jean out of Dutch Harbor. Using an underwater camera, Scott McEntire and Lowell Fritz investigated many sites (depths ranging from 40-90 feet) throughout Unalga Pass east of Unalaska Island from Priest Rock, Brundage Head, the mouth of English Bay, south to Cape Sedanka. While no Atka mackerel were observed on the video images, the habitat observed at most sites was similar to that described by Zolotov (1991) as used by Atka mackerel for nesting.

A series of day trips from Dutch Harbor, AK were conducted from July 27-August 6, 1998 aboard the vessel F/V Grand Aleutian by Robert Lauth, Scott McEntire, and John Lowell. The primary goals and activities of the second trip were: (1) To locate one or more nesting areas of Atka mackerel; (2) Conduct a survey of the area with a towed camera and using SCUBA-equipped divers; (3) Deploy an in-situ time-lapse camera near a nest to record male behaviors, such as defense and aeration of nests, and filial egg cannibalism/predation; and (4) Collect biological information on Atka mackerel to determine size/age/sex composition and their trophic and maturity status; requires collection of egg masses, otolith, gonad, and stomach samples; collected using jig/sport tackle. An underwater camera was deployed at numerous points throughout Unalga Pass from Cape Sedanka to Priest Rock, around Inner and Outer Signal Islands, and Egg Island. Additional places observed by camera included off Cape Morgan, Akutan Island and Unalga Island (to the east), and west around the north side of Unalaska Island to the mouth of Makushin Bay. Atka mackerel were observed on the water's surface near Outer Signal Island on the July 28. However, subsequent underwater observations using both camera and SCUBA divers found no evidence of nesting Atka mackerel at this location. Repeated diving and camera observations at numerous sites found no evidence of Atka mackerel spawning or male nest-guarding in nearshore waters to depths of approximately 80 feet. However, male nest guarding of other hexagrammids (e.g., rock greenling, *Hexagrammos lagocephalus*) was observed by both the camera and SCUBA divers in these nearshore, rocky, high-current areas.

Since early August is the time of peak spawning of Atka mackerel in the Aleutian Islands, our lack of success in observing nest-guarding is more likely due to looking in the wrong place than to looking at the wrong time. It is possible that they may spawn in deeper waters in the eastern Aleutian Islands than were investigated in this project, or that for some reason, there are no spawning sites in this general area. It appears likely, based on conversations with persons knowledgeable of the area and its history (e.g., Andy McCracken, John Lucking, Dustin Dickerson, Bobby Storrs, and others), that Atka mackerel used to spawn in Unalga Pass. However, it does not appear that spawning occurs here currently. These same individuals also mentioned that nearshore areas where spawning may occur currently are located further west, particularly in Nazan Bay on Atka Island and on the south and east sides of Amlia Island.

While no spawning aggregations or nesting areas for Atka mackerel were found during this first year, considerable knowledge was gained about diving in the Aleutian Islands and how to survey nearshore areas with camera and dive gear. Once located, surveys of Atka mackerel nesting areas could serve as indices of potential year-class size as well as yield valuable information on the life cycle of this important commercial and forage species. It is anticipated that additional funding will be sought to continue this research.

7. PROJECT: Effects of urban runoff on habitat capability in estuarine wetlands
Principal Investigators - Mitch Lorenz and K Koski (NMFS Alaska Fisheries Science Center - Auke Bay Lab)

Estuarine wetlands are generally considered among the most productive habitats for fish that sustain the worlds marine fisheries, yet little is known about their role in the productivity of FMP species for Alaska fisheries. Such habitat is among the most threatened by anthropogenic affects and NMFS has increasing responsibilities for its protection and restoration. In Alaska, nearly one half of the water bodies listed as impaired are listed due to urban runoff, yet little is known about the effects of urban pollutants on estuaries of impaired water bodies. By working in urban areas, both necessary research and community outreach can be done to develop the awareness and support needed to effectively protect and restore essential fish habitat.

Project objectives are to: 1) Identify and describe the “essential fish habitat” necessary to foster productive salmon populations in urban wetlands; 2) Explore poorly known habitat relationships of FMP species in estuarine wetlands to improve understanding of “essential fish habitat;” 3) Continue community outreach to develop public awareness and encourage public support for maintaining, protecting, and restoring “essential fish habitat;” 4) Help to coordinate NMFS “essential fish habitat” policy development with community-based visions for habitat protection and restoration.

Research done in 1998 established that FMP species use estuaries and tidal wetlands in both urban and rural areas either continually or seasonally. Estuaries are critical for salmon rearing and migration and salmon are particularly vulnerable to environmental change while in these habitats as their physiology makes drastic changes between freshwater and marine environments. Other FMP species (e.g., yellowfin sole, rock sole, starry flounder) and important forage species (sand lance, herring, eulachon, and many invertebrates) were also abundant in estuarine wetlands. Spawning and rearing of many such species was observed in estuarine wetlands studied in 1998.

Tasks such as water chemistry analysis, spatial habitat indexing, and groundtruthing for GIS interpretation were not completed in FY98 due to funding limitations.

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CURRENT RESEARCH ON THE EFFECTS OF FISHING GEAR
on Seafloor Habitat in the North Pacific
by Jon Heifetz

Since 1996, the Alaska Fisheries Science Center (AFSC) has been conducting several studies to specifically address the effects of trawling on benthic organisms and their habitat. (Heifetz, 1997). A summary of some of accomplishments of each of the major projects during 1996-98 is included below. After each project title, the principal investigator and affiliation are identified.

Effects of Trawling on Seafloor Habitat and Associated Invertebrate Taxa in the Gulf of Alaska
Principal Investigator - Lincoln Freese (Alaska Fisheries Science Center - Auke Bay Lab)

Effects of bottom trawling on "hard-bottom" (pebble, cobble, and boulder) seafloor were studied on the outer continental shelf in the eastern Gulf of Alaska in August 1996. A chartered trawler was outfitted with a Nor'eastern bottom trawl modified with 0.6-m tires in the boson and fitted with 0.45-m rockhopper discs and steel bobbins along the wings. Eight sites ranging in depth from approximately 200 to 250-m were subjected to a single trawl pass. A research submersible was then used to videotape each trawl path and a nearby reference transect to obtain quantitative data. Boulders were displaced, and large epifaunal invertebrates were removed or damaged by a single pass of the trawl (Figure 1). These structural components of habitat were the dominant features on the seafloor. There was a significant decrease in density and an increase in damage to sponges and anthozoans in trawled versus reference transects. Changes in density or damage to most motile invertebrates were not detected.

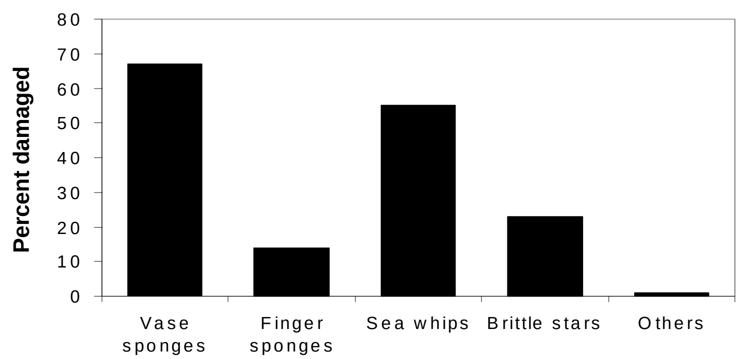

Figure 1. Incidence of damage to epifaunal invertebrates caused by experimental trawling in the eastern Gulf of Alaska. Adapted from Freese et al. (1998).

Delayed mortality of apparently undamaged invertebrates may have resulted in greater impact than we detected. Alternatively, over time some invertebrates may recover from damage. Accordingly, we returned to the study sites with a research submersible in July 1997 and videotaped the trawl and reference transects. Data from the videotape is currently being quantified. Striations on the seafloor caused by the trawl tire gear were readily apparent one year post-trawl. Large erect sponges that were torn or overturned by the trawl were also readily apparent and showed no visible signs of regrowth, and although damaged showed no signs of delayed mortality. Preliminary examination of the videotape suggests no significant differences in numbers of smaller sessile organisms or motile organisms between trawl and reference transects.

Retrospective Analysis of Commercial Bottom Trawl Activity and Benthic Community Structure in the Gulf of Alaska and Aleutian Islands

Principal Investigators - Catherine Coon and Thomas C. Shirley (University of Alaska Fairbanks), Jon Heifetz (Alaska Fisheries Science Center - Auke Bay Lab

The spatial and temporal patterns of bottom trawl effort in the Gulf of Alaska (GOA) and Aleutian Islands (AI) from 1990-1997 were analyzed. Haul data were obtained from the National Marine Fisheries Service (NMFS) domestic observer database (NORPAC) and included gear type, latitude, longitude, and NMFS regulatory and reporting areas. Trawl locations were plotted by management and habitat areas in a geographical information system (ARCVIEW-GIS). Trawl effort was projected as overall bottom trawl activity by year and categorized by NMFS research strata, International North Pacific Fisheries Commission (INPFC) area, and bathymetric range. The total numbers of observed tows for 1990-1997 were 53,833 in the GOA and 32,643 in the AI. If expanded to include unobserved tows, the totals were estimated to be 100,012 in the GOA and 37,036 in the AI. The areas of the highest estimated number of bottom trawls was on the continental shelf at a depth of 1-100 m in the AI and at a depth of 101-200 m in the GOA. Within the GOA, density of bottom trawls was 0.31/km^2 over all depths with the highest density (0.56/km^2) occurring on the continental slope at a depth of 301-500 m (Figure 2).

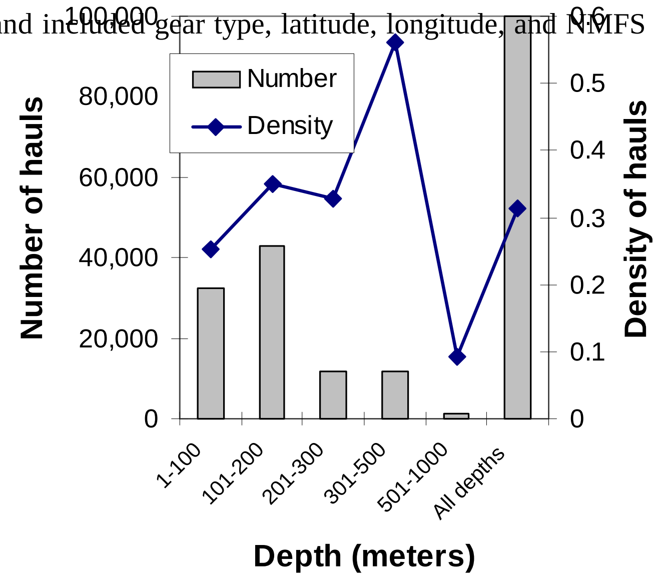

Figure 2. Estimated number and density (number per km^2) of bottom trawl hauls by depth strata in the Gulf of Alaska during 1990-97 based on the domestic observer program.

Areas of high bottom trawl density and low bottom trawl density are currently being compared using data from the NMFS triennial research survey. Species composition data from the research trawls will be used to describe attributes of community structure in areas of heavy and low trawl concentrations from similar depths.

Trawl Impact Studies in the Eastern Bering Sea

Principal Investigator - Robert A. McConnaughey (Alaska Fisheries Science Center - RACE Division)

Potential long-term (chronic) effects of bottom trawls on soft bottom benthos are being investigated by comparing benthic populations and community structure in selected areas of the Eastern Bering Sea (EBS). An historical analysis of commercial bottom trawl effort in the EBS (1933-95) identified pairs of heavily fished (HF) and unfished (UF) stations straddling the boundary of a trawl exclusion zone in Bristol Bay. In 1996, megafauna were collected at 84 of these 1-nm^2 sites using a modified NMFS 83-112 bottom trawl. Average water depth in the study area was 48 m. Analyses indicated that megafauna populations at the HF and UF sites were significantly different overall. More specifically, sedentary taxa (*e.g.* anemones, soft corals, sponges, whelk eggs, ascidians) and empty shells were less abundant in the HF area, resulting in reduced structural complexity of the seafloor. Mixed responses were observed in the crab, sea star, whelk and bivalve groups, suggesting that responses to trawls are complex and may ultimately depend on the ecology of the organism. The sedentary community was less diverse and more patchy in the HF area, while no effects were detected in the motile and bivalve communities (McConnaughey *et al*., 1998).

In 1997, chronic effects of bottom trawls on infauna were investigated at 40 of the HF and UF stations occupied during the 1996 megafauna study. Samples were collected with a 0.1 m^2 Sutar van Veen grab. Taxonomic processing to the family-level was completed in 1998, under contract with the University of Alaska Fairbanks. All 40 samples have been archived, in the event genus- or species-level processing is necessary. A total of 104 different families were represented in the samples. Multivariate and univariate analyses of potential population and community-level effects are pending.

A general evaluation of procedures and gears required for studies of short-term (acute) trawl effects and subsequent recovery of the benthos was initiated in 1997 and continued in 1998. Sidescan sonar and video surveys conducted in and around the study site revealed 0.5-1.5 m high sand waves (15-20 m wavelengths) and prominent lineations characterized by bedform ripples (1-2 m wavelengths) (Marlow *et al*., 1998). Analysis of physical attributes suggest these features were not the result of bottom trawls but, rather, reflect a high level of (natural) disturbance of the seafloor by tidal currents and storm waves. The 1997 "pilot study" also indicated a need for gear trials to evaluate options for real-time positioning of a bottom trawl while fishing. This capability is essential if acute trawl effects (and benthic recovery) are to be evaluated using superimposed sampling before and after commercial trawling. In May 1998, accuracies of three acoustic positioning systems were evaluated in an underwater tracking range maintained by the U.S. Navy in Puget Sound. Early analyses of these data indicate two of the three systems are suitable for bottom trawl positioning. More detailed analyses are underway to identify performance characteristics that will affect the final experimental design.

A Description of Seafloor Habitat in a Trawled Region and a Protected Region of the Central Gulf of Alaska
Principal Investigator- Robert P. Stone (Alaska Fisheries Science Center - Auke Bay Lab)

During June 4-17, 1998 a manned submersible was used to observe the seafloor at two areas near Kodiak Island that had been closed to bottom trawling since 1986. These areas were closed by the North Pacific Fisheries Management Council to assist in rebuilding severely depressed crab stocks. A bottom-trawl fishery occurs adjacent to the closed areas for walleye pollock, flathead sole, butter sole, arrowtooth flounder, Pacific cod, and several species of rockfish. The purpose of the study was to assess changes to the seafloor caused by chronic, long-term trawling. Study objectives were to compare areas closed to trawling to areas open to trawling to determine if differences exist for infauna composition, fish and invertebrate populations, and substrate characteristics including grain-size composition, biogenic structures, and total organic carbon content.

The two study sites selected were 160 km distant and extensive bottom trawling had occurred at both sites in the last five years. Twenty four transects were completed and visual counts and observations were made over 72 km of the seafloor. Each transect was 3000 m long and bisected the boundary between open and protected areas. Three substrate samples were collected with a Shipek bottom sampler along each transect. The seafloor at both sites was a relatively flat and unstructured bottom comprised of mostly fine sand and silt interrupted only by dense beds of several species of sea whips. Evidence of bottom trawling (e.g., trawl door furrows, broken sea whips) were observed at about one-third of the transects. Fish and invertebrates observed from the submersible included adult and juvenile flatfish, weathervane scallops, juvenile Tanner crabs, hermit crabs, sea anemones, sea stars, and sea whips. Video footage is currently being analyzed for counts of fish and invertebrates in the trawled and non-trawled zones. Infauna composition, sediment grain size, and organic carbon content analyses are near completion. Future studies on the effects of trawling are planned at these sites depending on the results of the 1998 study.

Fishing Impacts on Red-tree Coral (*Primnoa* spp.)

Principal Investigator - Ken Krieger (Alaska Fisheries Science Center - Auke Bay Lab)

In 1997 a manned submersible was used to observe bottom-trawl paths where coral was captured during bottom-trawl surveys in 1990 and 1996. The objective of this study is to describe megafauna species associated with coral, predation of coral by sea stars, and damage of coral caused by a bottom trawl. Trawl paths at depths of 365 m and 260 m were identified by moved boulders and broken coral. Preliminary analysis of data has been completed. At both sites, seven megafauna groups were associated with *Primnoa*: rockfish, sea stars, nudibranchs, crinoids, basket stars, and shrimp. Of the 162 individual rockfish observed, 83% were associated with *Primnoa*. Sea stars consumed 45% of the coral polyps outside the trawl path at one of the sites.

At the 365 m site, 13 large colonies of coral were observed and 8 of them were damaged by a bottom trawl. Three of the colonies had minor damage with 5-10% of the coral removed, and 5 colonies had major damage with 95-99% of the coral removed. Overall 38% of the coral in the trawl path was estimated to have been removed by a single trawl-haul. Nine broken pieces of coral were lying on the seafloor and all but 2 of the pieces contained live polyps that covered 5-50% of the branches.

Evaluation of Acoustic Technology for Seabed Classification

Principal Investigator - Robert A. McConnaughey (Alaska Fisheries Science Center - RACE Division)

Synoptic information about the seabed is required to enhance basic descriptions of essential fish habitat (EFH) and to support investigations of potential adverse effects of mobile fishing gear on EFH. To address these needs scientists in cooperation with industry have been examining the feasibility of acoustic seabed classification. In 1996, the *QTC View* seabed classification system was identified as the most appropriate technology for NMFS applications and a single unit was purchased. Various implementation problems were resolved in 1996, including signal saturation (“clipping”) related to the high power output of the NMFS *Simrad EK-500* echosounder. Preliminary classification catalogs for the eastern Bering Sea were generated during 1996 and field studies in Puget Sound, the Bering Sea and the Gulf of Alaska investigated operational limits of this technology. At this time, reasonable associations between bathymetry and seabed class suggested that continued R&D work was warranted.

In 1997 the *QTC View* system was deployed from the *Miller Freeman* during gear trials in Puget Sound and again in the Bering Sea during a routine hydroacoustic assessment of walleye pollock (Collins and McConnaughey, 1998). In both cases, a classification catalog was developed and ground truth samples collected. Grab samples were also collected to evaluate the accuracy of the acoustic classifications. As part of a thesis project (von Szalay, 1998), selected tracklines were repeatedly surveyed to evaluate classification precision and potential effects of vessel speed. Calibration of a *QTC View* system ordinarily is an iterative process that is not complete for a given geographical area until all significant seafloor types have been encountered. In heterogeneous areas with a cross-shelf gradient in seafloor properties, such as the Bering Sea, this may require multiple cruises. In order to expedite implementation of the *QTC View* technology, NMFS leased an ISAH-S hydrographic instrument from the QTC. The ISAH-S system uses classification algorithms that are identical to the *QTC View* system, but it alone is capable of storing “raw” acoustic data and post-processing it. As such, data from a single survey can be used for *QTC View* calibration *as well as* actual seabed classification. During Summer 1997, 7.7 million digitized echo returns were collected from the *Miller Freeman* along a 14,000 km trackline in the Bering Sea (~150 gigabytes of data representing approximately 4.5 million m^2 of seabed). Acoustic data were collected at two frequencies (38 kHz and

120kHz). A joint effort by the AFSC and the QTC in 1998 will process these data to: (1) assess the quality of all *ISAH-S* data collected during *Miller Freeman* cruise MF 97-08, (2) determine the optimum parameters for acoustic classification of the Bering Sea seafloor using a *QTC View* system, (3) identify acoustically distinct bottom types from the 38 and 120 kHz data sets, preferentially using unsupervised classification methods, (4) determine the optimum operational scenario for seafloor classification at each frequency, (5) produce final habitat classification maps for the full 38 kHz and 120 kHz acoustic data sets, and (6) identify primary and secondary sites for *QTC View* calibration and seafloor class groundtruthing in the Bering Sea. To date, data quality has been assessed by the QTC and work on subsequent phases of the project is underway. Approximately 100 grab samples collected during this cruise are currently undergoing laboratory grain size analysis for identification of the unsupervised sediment classes.

Effects of Trawling on Hard Bottom Habitat in the Aleutian Islands
Principal Investigator - Harold Zenger (Alaska Fisheries Science Center - RACE Division)

Gorgonian corals were once a major component of the bycatch of the Atka mackerel fishery in Seguam Pass in the Aleutian Islands. However, after twenty years of intense fishing effort coral is now infrequently caught. The studies objectives are: 1) examine whether the corals in the heavily trawled areas of Seguam Pass are more damaged and less abundant than in nearby, less trawled, areas; and, 2) investigate whether fish and invertebrates use coral forests for shelter. To meet these objectives, last spring, a towed underwater camera apparatus was constructed based on a design developed by engineers and scientists at the CSIRO Laboratory in Hobart, Tasmania. This apparatus uses underwater lighting and a color video camera to record images of the targeted habitat. In towing attitude, distance above bottom is controlled by counterbalancing flotation with the weight of a drag chain. The electronically controlled hydraulic winch uses electrical towing cable, which transmits power and video signals. Live-feed video enables the operator to view the bottom and to control the altitude of the camera body, using the remote winch controls.

Limited testing of the prototype occurred in Lake Washington and Puget Sound in early July, with satisfactory results. Sea trials and further testing occurred during a 5-day period in early August in the area between Akutan and Umnak Islands in the eastern Aleutian region. Initially, efforts were concentrated on learning the capabilities of the camera and winch combination to function over a wide range of bottom habitats and current conditions. Thirteen tows were completed in a variety of habitat types and current conditions, during which 11 hours of digital video recordings were made. Viewed habitats ranged from relatively flat, muddy bottom to high relief rock piles and pinnacles, in both low and high current areas. Generally the quality of the video recordings was good, although initially an emphasis was placed on conserving the apparatus intact. Therefore parts of earlier tows were sometimes too high above the bottom for good resolution of details. With increasing use, the apparatus was found to be quite robust and very maneuverable in all but the most extreme currents. Thus video images became better as operator experience increased. Due to early equipment failure the target area in Seguam Pass was not surveyed, but the experience that was gained towing in various other areas was invaluable to define the capabilities of the apparatus.

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MARINE PROTECTED AREAS

by Gretchen Harrington

Marine Protected Areas (MPAs) have been used as a management tool to protect biodiversity, habitats, viable populations, and ecological processes. MPAs can also provide long-term research and education opportunities, human uses, and existence value. MPAs are widely supported in the scientific literature, because they implement the precautionary approach by reducing risk and hedging against uncertainties, errors, and biases in fisheries management, thus providing insurance against fishery collapses (Clark 1996, Lauck et al. 1998, Agardy 1994, Holland and Brazee 1996, NRC 1998). In essence, MPAs are an ecosystem-based management concept; they can be used to retain critical types and ranges of natural variation in ecosystems (the “golden rule” of Holling and Meffe 1996).

The World Conservation Union (IUCN 1988) defines a MPA as any area of intertidal or sub-tidal terrain, together with it overlaying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment. The National Research Council (1998) defines a MPA as: “a spatially defined area in which all populations are free from exploitation.” Whether a MPA allows some harvesting of resources, or establishes a “no-take” reserve, all MPAs should prohibit ocean dumping, dredging or exploration for and development of non-renewable resources.

MPAs can range from strict preservation of species, habitats, and ecosystems and their natural processes to an integrated resource management regime that allows explicitly defined activities such as commercial fishing. The design of a MPA depends on the site specific circumstances. There are a number of MPA types, depending on their design. These include no-take MPA’s, harvest refugia, marine sanctuaries, marine reserves, multiple use MPAs, multiple objective MPAs, moving area closures, and MPA networks.

Goals of MPAs

MPAs can be an effective fishery management tool, especially when combined with other measures. The reasons for establishing MPA are diverse and situation specific. In general, MPA’s are a management tool to protect the natural environment from “serious” human impacts. Being able to define/measure “serious”, however, is the crux of the matter. There are two main sources of human impacts on fishery resources: 1) pollutions which affect the aquatic environment and in turn affects the fishery resources (especially early life history stages and nursery areas), and 2) overfishing (excessive removals and concomitant habitat alternations (positive or negative)). MPAs can be effective in achieving the following:

<u>Ecosystem Protection</u>: MPAs can preserve marine ecosystems (or representative ecosystems), ecological processes, and special natural features in their natural state and provide reference sites and benchmarks for continued monitoring of ecosystem integrity, structure, and function (Lauck et al. 1998, Ballantine 1995a).

<u>Biodiversity Protection</u>: MPAs can protect marine biodiversity (genetic diversity) by choosing MPAs that represent components of biodiversity, that provide viable self-sustaining entities which act as store houses/safe houses for reintroduction and rehabilitation, and that maintain ecological processes that underpin the biological diversity of a region.

<u>Habitat Protection</u>: MPAs can protect sensitive habitat types, nursery and settlement habitats (Roberts 1997, Rowley 1994), and protect and conserve Essential Fish Habitat (Langton et al. 1996).

Enhancing Fisheries: Spatial refuges can be an important tool of fisheries management to prevent overfishing, provide stock replenishment, contribute to improved fishery yields, and evaluate management success. MPAs are also established to protect essential life stages of commercial species, spawning grounds, and other areas critical to the viability of the stock. “Protected areas can serve as a hedge against inevitable management limitations, thus greatly enhancing the long-term sustainable exploitation of fisheries resources. Marine reserves would also provide an escape from the need of ever more detailed and expensive stock assessments and would be invaluable in the rehabilitation of depleted stocks” (Lauck et al. 1998).

Theoretically, MPAs can also serve as a source for replenishing exploited stocks and provide refuges to maintain stocks of vulnerable species. MPAs are thought to enhance fisheries in two ways: larval dispersal and migration (‘spillover’). MPAs can increase reproductive biomass of fish species and increase the size of the individual fish inside the reserve, and these fish then, through larval dispersal and migration or ‘spillover’ replenish the fisheries outside the reserve (Roberts 1997). Lauck et al. (1998), using a single species model, show that marine reserves can provide protection for a stock and higher long-term catch of the stock outside the reserve. Rowley (1994) provides case studies where reserves support denser populations of larger individuals than are found outside the reserve. These populations were shown to ‘spillover’ into fisheries near the reserve boundaries.

Scientific Research: MPAs provide opportunities for scientific research on marine ecosystems, organisms, and special features (Lauck et al. 1998, Allison et al. 1998). MPAs can provide an ecological benchmark, a baseline, and scientific control from which to conduct scientific research to expand knowledge and understanding of marine ecosystems (Ballantine 1995a).

Recreation, Tourism, Education: MPAs can provide recreation, tourism, and educational opportunities.

Limitations of MPAs

Although MPAs are widely supported in the literature, the actual benefits of MPA have not been clearly documented. This is mainly due to the lack of clearly defined management objectives and lack of monitoring and evaluation (Allison et al. 1998, McArdel 1997). There are also some serious limitations of MPAs (Allison et al. 1998). MPAs cannot protect against threats like contamination by chemicals, dispersive pollutants, disease epidemics, or the spread of exotic species. MPAs cannot encompass fundamental oceanographic processes or mitigate the effects of episodic climatic events and climatic change. Nor can MPAs protect all life stages of many species, especially species with both planktonic larvae and pelagic adults.

For the effectiveness of the reserves to be judged, the goals of establishing a MPA and the problems addressed by the action must be explicit at the onset of planning (Allison et al. 1998, Thackway 1997). This process includes identifying the base-line data needed to select the site, the expected level of success, and how the MPA will be evaluated. Scientific justification of reserve design and implementation is necessary to effectively attain conservation objectives, although there is debate how much scientific knowledge is required to establish a MPA (Langton et al. 1996, Auster et al. 1997, Steneck et al. 1997). Dayton (1998) addresses this problem by arguing that the burden of proof should be shifted from the scientific justification for why the area should be protected to justification that the activities cause no harm to the area.

Criteria for MPA Selection

The first step in creating an effective MPA is to specify explicit goals and objectives. The next step is to gather the preliminary information required for effective design of the MPA that achieves these goals and objectives. To be effective, extensive research is required before a MPA is established. The design criteria of the MPA is situation specific and depends on the scientific information available and social, political, and economic considerations (Lauck et al 1998, Allison et al 1998). The design criteria — size, number, shape, location, restrictions — are then determined by the accumulated research. The criteria and reserve design should be responsive and flexible to change according to new scientific information or changing conditions (Rowley 1994, Agardy 1994, Roberts 1997). For example, if the goal was to create a MPA that protected juvenile red king crab settlement habitat, then preliminary scientific information would be gathered that identified things like the characteristics of the required habitat, the locations of that habitat type. Once the locations of juvenile crab settlement habitats are identified, potential sites for MPA are chosen and criteria, such as size, shape, number of reserves, and restrictions, are developed.

Types of criteria for selection of MPAs (Thackway 1997).

Biogeographic importance:	Rare biogeographic qualities or types.
Naturalness:	Extent to which the area has been protected from human impacts.
Ecological importance:	Threatened or rare habitat; diversity; representativeness; habitat for threatened, endangered or rare species; effectiveness; regional significance; size; rarity; fragility; ecological/ geographical location; importance to wildlife abundance.
Economic importance:	Unspecified contribution (existing and/or potential); recreation and tourism; productivity; breeding area for economically important species.
Social importance:	Unspecified contribution (existing and/or potential); value to local, national and international communities; education; historical and archaeological values; community stewardship; aesthetic values; cultural resources.
Management / planning:	Practicality/feasibility; consideration of buffers and boundaries; accessibility; risks and threatening processes; shape.
Scientific importance:	Monitoring history/research investment.
Level of significance:	Area is listed as important to national and/or international community.

The size and shape of a MPA should be determined by objectives and by the scale of threats to the ecosystem, habitats, and species' populations. Some authors predict that an MPA should encompass from 20% (Ballantine 1997) to 50% or more of the species usual habitat to be effective as a hedge against overexploitation (Clark 1996) or encompass 50% of the original population (Lauck et al. 1998, Roberts 1997). If the goals and objectives of the MPA were to protect species from overfishing, the MPA must be large enough to retain a large portion of the population of the protected individuals within it for long enough for the effects of protection to be realized (Rowley 1994). To protect genetic diversity of small populations and avoid population crashes, reserves should be large enough to maintain large breeding populations of species of concern (Holling and Meffe 1996). Ideally, a MPA should be large enough to protect the resource in the event of overfishing outside the MPA. The information needs would then include knowing the individual movement rates (daily, seasonal, migratory, larval transport) of the species and extent of fishing pressure outside the reserve. The practical size will also be determined by social and economic constraints.

The other consideration of reserve design is establishing a network or system of reserves that work together to protect representative ecosystems or representatives of all types of ecosystems in a given region. Ballantine (1997, 1995a) advocates for a network of reserves that represent of all biogeographic and major ecological systems because protected areas do not function in isolation from their surroundings.

Monitoring and Enforcement

One of the main objectives for establishing a MPA is for long-term scientific research to answer critical questions that range from concerns about the species of interest to ecosystem function, fundamental processes, and community interactions. According to Allison et al. (1998), reserves treated as experiments may be the most effective method of filling knowledge gaps. Besides providing vital knowledge, monitoring needs to be conducted to determine if the MPA is effective in achieving the established goals and objectives. The optimal monitoring programs would collect data directly applicable to evaluating reserve effectiveness (Allison et al 1998). Monitoring provides a feedback loop so that management can be responsive to environmental changes and new knowledge (Agardy 1994). Rowley (1994) points out that understanding the effects of the reserve requires baseline information from before the area was protected. Also, MPAs can provide an ecological baseline and scientific control from which to evaluate management actions outside the reserve and the effects of the reserve on the outside system. Along with monitoring, adequate enforcement is vital for an effective reserve (Clark 1996, Lauck et al. 1998).

Case Studies

MPA have been established in different parts of the world, from Australia to British Columbia. Governmental and Non–governmental organization web sites are useful places to learn about the MPA programs, symposiums and workshops around the world. Some examples of useful web sites are included below.

Canada: MPAs in Canada are part of the national strategy for sustainable development, integrated management, and precautionary approaches. Canada's National Marine Protected Area Program's Internet site, http://habitat.pac.dfo.ca/, contains a complete description of Canada's MPA program. MPAs are established under Canada's *Oceans Act* (Section 35: see Appendix A), which states that a marine protected area is an area of sea that forms part of the internal waters of Canada, the territorial sea of Canada or the exclusive economic zone of Canada; and has been designated under this section for special protection for one or more of the following purposes:

(a) conservation and protection of commercial and non-commercial fisheries resources, including marine mammals and their habitats;
(b) conservation and protection of endangered or threatened marine species, and their habitats;
(c) conservation and protection of unique habitats;
(d) conservation and protection of marine areas of high biodiversity or biological productivity;
(e) conservation and protection of any other marine resource or habitat as is necessary to fulfill the mandate of the Minister of Fisheries and Oceans.

Australia: Approximately 300, or one third of the world's MPAs, have been established in Australia. An overview of Australia's MPAs is available on the Internet at: http://www.environment.gov.au/portfolio/esd/coast_marine/or2000/seanotes/mpa.html. Currently, the Australian government is working on creating a coordinated nationwide system of MPA that will protect areas representative of all major ecological regions. Environment Australia's Ocean Rescue 2000 workshop, Developing Australia's Representative System of MPAs, discusses developing national criteria and guidelines for the identification and selection of a representative system of MPAs. The workshop proceedings are available at: Http://www.erin.gov.au/portfolio/esd/coast_marine/or2000/mpa.

California: McArdle (1997) compiled a centralized source for information on California's 104 MPAs that provides the purposes, locations, and regulations for each MPA. NOAA Pacific Fisheries Environmental Laboratory is conducting research on habitat refugias for west coast rockfish. Proceedings from the Marine Harvest Refugia for West Coast Rockfish: A Workshop are available at http://www.pfeg.noaa.gov/whats_new/refugia_index.html. According to the executive summary, "the objectives of the workshop were to (i) assess the current and future needs, benefits, and implementation of harvest refugia to protect and manage rockfish populations, and (ii) develop recommendations for establishing and monitoring rockfish refugia on the west coast."

International: There is a lot of work on the international level for the promotion and coordination of MPAs. UNESCO's Man and the Biosphere Programme aids countries in establishing biosphere reserves with the goals of conservation, research, and sustainable development. Biosphere reserves include three levels of protected areas, a highly protected core, less protected buffer zones and a least protected transition zone. Australia's Great Barrier Reef Marine Park is an example of a biosphere reserve (Sobel 1993). Also, the IUCN Protected Areas Programme, the World Commission on Protected Areas, and the World Bank all provide assistance for the development and coordination of MPAs.

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SEABIRDS

by Vivian Mendenhall

Status and trophic relationships of seabirds -Alaska supports North America's greatest concentration of seabirds, owing to its productive marine waters and abundant nesting habitat. Approximately 38 seabird species nest in Alaska, including 36 million birds at 470 colonies in the BS/AI and 12 million birds at 20,000 colonies in the GOA. In addition, up to 50 million shearwaters and 3 albatross species feed in Alaskan waters but breed farther south. Characteristics of seabird biology include delayed maturity, long life, low reproductive rates, and dependence on the sea as their source of food. The status of most seabird populations is unknown. For those populations monitored, most are generally stable, whereas in some locations, species may be increasing or decreasing. Attached Tables 1-3 list recent population trends for Alaskan seabirds.

One seabird species that enters Alaskan waters, the Short-tailed Albatross, is endangered. The entire world population in 1995 was estimated as 800 birds; 350 adults breed on two small islands near Japan (H. Hasegawa, pers. comm.). The population is growing but is still critically endangered because of its small size and restricted breeding range. NMFS has consulted with the U.S. Fish and Wildlife Service (USFWS) concerning possible impacts of groundfish fisheries on Short-tailed Albatross populations, as required by the Endangered Species Act. USFWS has issued a Biological Opinion that permits a small incidental take of Short-tailed Albatrosses (as of February 1997, the permitted take is 4 birds in two years). Bycatch of albatrosses is discussed further below.

Most population trends in high-latitude seabirds have been associated with changes in food availability (Birkhead and Furness 1985; Piatt and Anderson 1996). Other threats can affect seabird populations locally. The most serious of these in Alaska has been (and remains) the introduction of alien predators, both foxes (Bailey 1993) and rats from vessels (Loy 1993). Oil spills may cause declines in some colonies, but even the *Exxon Valdez* spill may have affected populations less than changes in food supply and habitat (Hatch and Piatt 1995, Piatt and Anderson 1996).

Seabirds obtain their food at sea by picking prey from the surface or by diving and pursuing it underwater. Forage fish are the principal diet of more than two thirds of Alaskan seabird species (reviewed in NPFMC 1996). Capelin and sandlance are crucial to many bird species; other forage fish include Myctophids, herring, Pacific saury, and walleye pollock. Many seabirds can subsist on a variety of invertebrates and fish during non-breeding months but can raise their nestlings only on forage fish (Sanger 1987; Vermeer et al. 1987).

Seabird population trends are largely determined by forage fish availability (Birkhead and Furness 1985). Although seabirds are adapted to occasional years of poor reproduction, a long-term scarcity of forage fish leads to population declines, usually through breeding failure rather than adult mortality. Seabirds depend on forage fish that are small (5 to 20 cm), high in energy content, and form schools within efficient foraging range of the breeding colony. Seabirds such as kittiwakes and terns can take prey only when they are concentrated at the surface. These species are affected more frequently by food shortage than are diving seabirds such as murres, murrelets, puffins, and cormorants. Although Alaskan seabirds consume several species of fish, only one or two forage species are available near most colonies. If an important fish stock is depleted locally, birds may have no alternative and breeding fails (Springer 1991).

Ecological interactions between seabirds and fisheries - Fisheries and seabirds compete for forage fish, but this interaction is difficult to evaluate. Climatic fluctuations cause major fluctuations in seabird food resources (Wooster 1993), but fisheries also contribute to some forage fish trends (Duffy 1983; Steele 1991). Pollock and herring are the only food species of Alaskan seabirds for which there are large directed fisheries.

The pollock fishery may have impacted this food source by temporarily depleting local forage concentrations on which breeding birds depend near their colonies (Francis et al. 1996). There may also have been indirect ecosystem effects on other forage species (Francis et al. 1996; Piatt and Anderson 1996). Direct impacts on important seabird forage species in most parts of Alaska, such as capelin and sand lance, were minimized by Amendments 36/39, which prohibit directed fisheries for these species.

Fisheries and seabirds may interact through the food chain in other ways. Fish processing provides food directly to scavenging species such as Northern Fulmars and large gulls. This can benefit populations of some species, but it can be detrimental to others which gulls may displace or prey upon (Furness and Ainley 1984). Impacts of seabird predation on fish populations have variously been estimated as minor to significant (reviewed by Croxall 1987). The ways in which food availability for seabirds is determined by fluctuations in fish stocks are still very incompletely understood. However, understanding of these ecosystem processes is beginning to improve at present.

Bycatch of seabirds

Seabirds are caught incidentally to all types of fishing operations. However, longlines are more hazardous to birds than other groundfish gear. Longlines catch surface-feeding seabirds as they attempt to capture baits during setting of the line. Some birds are caught on hooks and drown. Some take of birds also occurs in trawls and pots, and through striking the superstructure of vessels. Inshore fisheries also take seabirds. Gillnets catch both surface-feeders and diving birds (Wynne et al. 1991, 1992); bycatch in seines has been reported anecdotally but never investigated. Bycatch of seabirds in groundfish fisheries has been monitored by fishery observers since 1990. Since 1993, observers have been trained by USFWS identify birds to genus or species. Birds found in the observers' random samples are reported on standard bycatch forms; in addition, Short-tailed Albatrosses are reported whenever they are caught. A preliminary rough estimate of average annual mortality of seabirds in groundfish fisheries (Wohl et al. 1995) is 9,600 birds.

Several Short-tailed Albatrosses were reported caught in the longline fishery since 1990: two in 1995, one in October 1996, and two in October 1998. Both 1995 birds were caught in the vicinity of Unimak Pass and were taken outside the observers' statistical samples; the 1996 bird was caught near the Pribilof Islands in an observer's sample. Details of the 1998 incidents are included in the 98-108 NMFS Information Bulletin (see attached).

Measures to deter birds from approaching longline gear have been required for Alaskan groundfish fisheries since April 1997. Similar regulations are being drafted for the halibut fishery. Fishers are contributing to the development of deterrent devices for Alaskan waters, as provided for in the regulations. NMFS is currently designing a study to document the effectiveness of various deterrent devices in Alaskan waters.

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INFORMATION BULLETIN (98-108) October 22, 1998
Protected Resources Division
907-586-7235

NMFS REPORTS THE INCIDENTAL TAKE OF 2 SHORT-TAILED ALBATROSSES IN THE BSAI HOOK-AND-LINE GROUNDFISH FISHERY

The National Marine Fisheries Service (NMFS) reports the incidental take of 2 endangered short-tailed albatrosses in the hook-and-line groundfish fishery of the Bering Sea/Aleutian Islands (BSAI). The first bird was taken on September 21, 1998 at 57 30'N, 173 57'W. The bird had identifying leg bands from its natal breeding colony in Japan. It was 8 years old. In a separate incident, one short-tailed albatross was observed taken on September 28, 1998 at 58 27'N, 175 16'W but the specimen was not able to be retained. Identification of the bird was confirmed by U.S. Fish and Wildlife Service (USFWS) seabird experts. The confirmation was based upon the observer's description of key characteristics that matched that of a subadult short-tailed albatross to the exclusion of all other species. A second albatross was also taken on September 28 but the species could not be confirmed (3 species of albatross occur in the North Pacific). Both vessels were using seabird avoidance measures when the birds were hooked, according to Jim Balsiger, Acting Administrator, Alaska Region, NMFS.

The current world population of the endangered short-tailed albatross is approximately 1000 individuals. The short-tailed albatross is protected by the Endangered Species Act (ESA) and under the law, an incidental take level of 4 birds is allowed during the 2-year period of 1997 and 1998 for the BSAI and Gulf of Alaska (GOA) hook-and-line groundfish fisheries. If the incidental take limit is exceeded during that time, any operations causing such take must cease pending reinitiation of consultation with the USFWS.

The NMFS Regional Office, NMFS Groundfish Observer Program, and the USFWS Offices of Ecological Services and Migratory Bird Management are actively coordinating efforts and communicating with each other in response to these take incidents and are complying to the fullest extent with ESA requirements to protect this species. To assist in this coordinated effort, NMFS urges hook-and-line vessel operators to use great caution when fishing in these areas or when short-tailed albatross are sighted. NMFS reminds operators of all hook-and-line vessels in the BSAI and GOA that they are required to employ multiple seabird avoidance measures:

> Baited hooks must sink as soon as they are put in the water. This may best be achieved by weights applied to the groundline at frequent intervals.
>
> If offal is discharged while gear is being set or hauled, it must be done in a manner that distracts seabirds from baited hooks. The discharge site must be either aft of the hauling station or on the opposite side of the vessel from the hauling station.
>
> Make every reasonable effort to ensure that birds brought on board alive are released alive and that whenever possible, hooks are removed without jeopardizing the life of the birds.

For vessels greater than or equal to 26 ft length overall, the vessel operator must also employ one or more of the following measures:

> Tow a streamer line or lines during deployment of gear to prevent birds from taking hooks;

Tow a buoy, board, stick, or other device during deployment of gear at a distance appropriate to prevent birds from taking hooks;

Deploy hooks underwater through a lining tube at a depth sufficient to prevent birds from settling on hooks during deployment of gear; or

Deploy gear only during the hours specified at 50 CFR 679.24(e)(3)(iv), i.e. night-setting, using only the minimum vessel's lights necessary for safety.

Towed avoidance devices seem to be most effective when they are deployed directly over the hook-and-line gear and when they extend far enough behind the stern of the vessel such that baited hooks sink deep enough before they reach the end of the towed device or the end of the streamer line and thus cannot be reached by birds. This information bulletin provides information about regulations at 50 CFR Parts 679.24(e) and 679.42(b)(2). See these cites for the specific regulations.

Table 1. Recent population trends of breeding Alaskan seabirds: Fulmar, storm-petrels, cormorants, and gulls. Increase: +; Stable: 0; Decline: --; trend unknown: ?; Species not present: blank.

Other notes: Trends are shown for the last 5 years, for species monitored over 4 or more years. See text for earlier trends. Each area covers about 500km of coast and includes 1 or more monitoring sites. If trends vary among colonies in area, trend is shown for overall population of area. No information on trends exists for double-crested cormorants gulls other than glaucous-winged gull, or jaegers. Trends in albatrosses and shearwaters are described in text. For sources, see text.

	Northern Fulmar	Storm-Petrels	Pelagic Cormorant	Red-faced Cormorant	Glaucous-winged Gull
Chukchi Sea			?		
N. Bering Sea	+		?		
Central & SE Bering Sea	+		?	0	?
Bristol Bay			+	--	?
W. Aleutians		+	--	?	--
C. Aleutians	?	+	?	?	?
E. Aleutians		+	--	--	0
W. Gulf of Alaska	?	?	?	?	?
N. Gulf of Alaska		?	--	--	0
SE Alaska		+	+		+

Table 2. Recent population trends of Alaskan seabirds: Kittiwakes, murres, and guillemots. Increase: +; Stable: 0; Decline: --; trend unknown: ?; Species not present: blank.

Other notes: Trends are shown for the last 5 years, for species monitored over 4 or more years. See text for earlier trends. Each area covers about 500km of coast and includes 1 or more monitoring sites. If trends vary among colonies in area, trend is shown for overall population of area. No information on trends exists for terns or black guillemot. For sources, see text.

	Black-legged Kittiwake	Red-legged Kittiwake	Common Murre	Thick-billed Murre	Pigeon Guillemot
Chukchi Sea	0		+	+	
N. Bering Sea	0		0	--	?
Central & SE Bering Sea	0	0	+	0	?
Bristol Bay	0		0		?
W. Aleutians	+	0	?	+	?
C. Aleutians	0		?	?	?
E. Aleutians	?		0	0	?
W. Gulf of Alaska	?		?	?	?
N. Gulf of Alaska	0		+		--
SE Alaska			--		?

Table 3. Recent population trends of Alaskan seabirds: Auklets, murrelets, and puffins. Increase: +; Stable: 0; Decline: --; Trend unknown: ?; Species not present: blank.

Other notes: Trends are shown for the last 5 years, for species monitored over 4 or more years. See text for earlier trends. Each area covers about 500km of coast and includes 1 or more monitoring sites. If trends vary among colonies in area, trend is shown for overall population of area. No information on trends exists for other auklets, ancient murrelet, rhinoceros auklet, or horned puffin. For sources, see text.

	Least Auklet	Crested Auklet	Kittlitz's Murrelet	Marbled Murrelet	Tufted Puffin
Chukchi Sea			?		?
N. Bering Sea	?	?	?		?
Central & SE Bering Sea	?	?			?
Bristol Bay			?	?	?
W. Aleutians	?	?	?	?	?
C. Aleutians	--	0	?	?	?
E. Aleutians	?	?	?	?	+
W. Gulf of Alaska	?	?	?	?	?
N. Gulf of Alaska			--	0	0
SE Alaska			?	?	?

MARINE MAMMALS

by John Sease and Rich Ferrero

Harbor seals--During 1998, the National Marine Mammal Laboratory conducted aerial assessment surveys for harbor seals (*Phoca vitulina richardsi*) in the southern portion of southeast Alaska, from Frederick Sound to the US/Canadian border. The northern portion of southeast Alaska was surveyed in 1997. Two observers worked out of Petersburg and 5 observers used Ketchikan as their base of operations. From 18-28 August, the entire coastline was surveyed from small, single-engine aircraft equipped with floats, at an altitude of 200-250 m (700-800 ft.). Observers estimated the number of seals hauled out and took photographs of all seal haulouts. More accurate counts from the photos will be made at NMML during the fall. Results from the two surveys will be combined to produce an overall estimate for Southeast Alaska.

When seals are censused from the air, an unknown number of seals are in the water and not present at the haulout sites. A companion project to the assessment surveys is development of a correction factor for each haulout type (rocky, sandy, and ice) to account for seals not present at the time of the census surveys. This is accomplished by capturing 20-40 seals and attaching a small VHF radio transmitter to the left rear flipper. The proportion of radio-tagged seals hauled during subsequent surveys should be representative of all seals at the haulout. The resulting correction factor is then applied to the population estimates derived in the assessment analysis. The estimates are then adjusted upwards to account for those seals not present during the aerial census surveys.

Correction factors have been developed previously for seals hauling out on rocky and sandy substrates. Little is known about the seals hauling out on glacial ice since no one has been able to successfully capture one. The NMML developed new capture techniques using a variety of net materials and types and net deployment methods. In early August, the NMML successfully captured 19 seals at Aialik and Peterson Glaciers in the Kenai Fiords National Park near Seward, Alaska. We tracked the movements of these radio-tagged seals from aircraft (22 August - 2 September) and remote data collection computers (19 August to about 8 October). These data will be analyzed during the fall and winter. Results from the assessment and correction factor surveys will be used to estimate the number of harbor seals in Alaska and determine key components used in the NMFS annual stock assessment report.

Northern fur seals--Northern fur seals (*Callorhinus ursinus*) were listed as depleted in 1988 under the Marine Mammal Protection Act. Much of the research effort for fur seals takes place on the Pribilof Islands (St. Paul and St. George). The NMML conducts counts of adult males (bulls) annually, and counts of pups biennially. Analysis of the 1998 bull and pup counts is not completed, but preliminary results suggest a slight decrease in fur seal numbers on both of the Pribilof Islands. From 1996 to 1997 the total number of adult males on the Pribilof Islands decreased by 5.4%. Because of the high variability in these counts, however, several more years of data are needed to determine if a trend exists. The total estimated number of pups born on St. Paul Island in 1996 (170,125) was not significantly different from the 1990, 1992, and 1994 estimates. The 1996 estimate of number of pups born on St. George Island (27,385) suggested that a downward population trend observed on the Island since the mid-80s may have abated. However, preliminary data collected in 1998 indicate that pup numbers have decreased again.

Beluga whales--The NMML flew aerial surveys of the isolated stock of beluga whales in Cook Inlet, Alaska, during June/July of 1993-98. This included nearly 100% of the coastal areas each year, and with the addition of offshore transects, systematic searches encompassed 13-29% of the entire inlet. Beluga whales were concentrated in a few dense groups in shallow areas near river mouths in the northern portion of upper Cook Inlet. Very few belugas occurred elsewhere. Over the past three decades, there have been decreases in sightings of beluga whales both in offshore areas and in lower Cook Inlet. Since 1995, there have been no sightings in our surveys south of the upper inlet.

Steller sea lions--NMFS and ADF&G conducted surveys of Steller sea lion pups and non-pups during June and July 1998 from Southeast Alaska to the western Aleutian Islands. Although 1998 was a range-wide survey year, results are not yet available for areas outside of Alaska.

In general, numbers of non-pups in the western stock (west of 144°W) continued to decline in 1998. In the Kenai to Kiska area, non-pup numbers at trend sites decreased by −12.8% from 1994 to 1998 (18,713 to 16,315) and 8.9% (17,900 to 16,315) from 1996 to 1998 (Table 2). This compares to a Kenai to Kiska decline of 4.6% from 1994 to 1996. The Aleutian Islands as a whole declined by 7.3% from 1996 to 1998, as compared to a marginal increase (+1.1%) from 1994 to 1996. Combined, the western and central Gulf of Alaska declined 12.4% from 1996 to 1998, and 4.0% from 1997 to 1998. The central Aleutian Islands (Islands of Four Mountains to Kiska) was the one area that did show a marginal increase (+ 4.2%) from 1996 to 1998.
Although the numbers for Southeast Alaska show a decline, only 18 sites were surveyed in 1998, and other indications, particularly pup count results (below) suggest that the population in this areas is stable. Survey coverage in the eastern Gulf of Alaska was too incomplete to provide a reliable trend for non-pups.

NMFS and ADF&G conducted counts of Steller sea lion pups at all rookeries in Alaska, from the Forrester Complex in Southeast Alaska to Attu Island in the western Aleutian Islands during 19 June to 5 July 1998. Since 1994, the last range-wide pup counts, pup numbers decreased by 10.8% (from 14,198 pups to 12,670) at all rookeries (Table 2). For the western stock (reflected by the counts from Kenai to Kiska) the decline was 19.1% over 4 years. In general, pup numbers were up slightly in parts of the central Aleutian Islands (8 rookeries from Seguam Island to the Delarof Islands), but down elsewhere. Rookeries in the western Aleutian Islands (particularly those in the Near Islands: 3 rookeries at Attu and Agattu islands) were counted completely for the first time in 1997. Pup numbers at these three rookeries declined by 18.0% in one year (979 pups to 803 pups). The 2 rookeries in the eastern Gulf of Alaska declined 23.7% from 1994 to 1998, but increased 13% from 1997 (610 pups to 689). Pup numbers in Southeast Alaska have increased 12.3% from 1994, but showed little change from 1997 to 1998.

Harbor porpoise and Dall's porpoise - Researchers from the NOAA National Marine Mammal Laboratory conducted line transect aerial surveys for harbor porpoise (*Phocoena phocoena*) and Dall's porpoise (*Phocoenoides dalli*) from 27 May to 28 July 1998 in the Gulf of Alaska (offshore waters from Cape Suckling to Unimak Pass), Prince William Sound, and Shelikof Strait. The survey aircraft was a Twin Otter flown at an altitude of 500 ft and an airspeed of 100 knots. Sawtooth lines covered the offshore waters from Cape Suckling to Unimak Pass (offshore of Kodiak Island) from about 15 nmi seaward to the 1,000 fathom line. A series of zigzag lines covered Shelikof Strait, between the Alaska Peninsula and Kodiak Island. Larger inlets and bays were also included in the survey. The survey in Prince William Sound consisted of two lines: one covering the central waters and one along the coast with extensions into selected inlets. Two primary observers surveyed from bubble windows on each side of the aircraft. A third observer, viewing directly beneath the aircraft from a belly window, recorded porpoises missed on the trackline by the primary observers.

Poor weather restricted the completion of the entire planned survey. Survey lines were completed in Prince William Sound and an adequate number of survey miles were completed offshore from Cape Suckling west along the Kenai Peninsula, offshore of Kodiak Island, west to Sutwik Island (Alaska Peninsula), and in Shelikof Strait. We flew a total of 5,722 nm, with sightings of 83 harbor porpoise, 69 Dall's porpoise, 13 killer whales, 47 humpback whales, 24 fin whales, 1 Cuvier's beaked whale, 25 harbor seals, 20 Steller sea lions, and 1 northern fur seal. We will use these data to estimate annual abundance of harbor porpoise and

Dall's porpoise, which is one of the key pieces of information needed to manage marine mammal-fishery interactions, as required under the Marine Mammal Protection Act. A report will be available by June 1999.

Table 1. Counts of **non-pup** Steller sea lions at Trend Sites (rookeries and haulouts) during aerial surveys in Alaska, 1994 to 1998.

Region	Non-pup counts at Trend Sites 1994	1996	1998	Percent change 1994-98	1996-98
Western Aleutian Islands	2,037	2,190	1,913	− 6.1	−12.6
Central Aleutian Islands	5,790	5,528	5,761	< 1%	+ 4.2
Eastern Aleutian Islands	4,421	4,716	3,847	−13.0	−18.4
Western Gulf of Alaska	3,982	3,741	3,361	−15.6	−10.2
Central Gulf of Alaska	4,520	3,915	3,346	−26.0	−14.5
Kenai to Kiska subtotal	18,713	17,900	16,315	−12.8	− 8.9

Table 2. Counts of Steller sea lion **pups** in Alaska, 1994 to 1998.

Region	No. of rookeries	1994	1997	1998	Percent change 94-98	97-98
Western Aleutian Islands	4		979	803		-18.0
Central Aleutian Islands	16	3,162		2,862	-9.5	
Eastern Aleutian Islands	6	1,870		1,516	-18.9	
Western Gulf of Alaska	4	1,662		1,493	-10.2	
Central Gulf of Alaska	5	2,831		1,876	-33.7	
Eastern Gulf of Alaska	2	903	610	689	-23.7	+13.0
Western Stock subtotal (Kiska to Seal Rocks)	33	10,428		8,436	-19.1	
Southeast Alaska	3	3,770	4,160	4,234	+12.3	+ 1.8

SUMMARY OF THE DRAFT BIOLOGICAL OPINION
Endangered Species Act, Section 7 Consultation on Steller Sea Lions

by Tim Ragen

PURPOSE AND CONSULTATION HISTORY

Section 7(a)(2) of the Endangered Species Act, 16 U.S.C. § 1534, et. seq., requires that each Federal agency shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species. When the action of a Federal agency may adversely affect a protected species, that agency is required to consult with either the National Marine Fisheries Service or the U.S. Fish and Wildlife Service, depending upon the protected species that may be affected. The protected species of concern include listed cetaceans, salmon, seabirds, and the Steller sea lion.

DESCRIPTION OF THE PROPOSED ACTIONS

This consultation focuses on three fisheries actions and their potential effects on the western population of Steller sea lions. Those actions, and the reasons for consulting are:

- *Authorization of an Atka mackerel fishery under the Bering Sea/Aleutian Island (BSAI) Groundfish Fishery Management Plan (FMP) between 1999 and 2002.* Consultation on this fishery was initiated because of new information indicating fishery-induced localized depletion of Atka mackerel stocks that could have a detrimental effect on the foraging of Steller sea lions or other protected species.

- *Authorization of a walleye pollock fishery under the BSAI groundfish FMP between 1999 and 2002*. Consultation on this fishery was initiated because of a new scheme for allocation of pollock TAC to inshore/offshore sectors of the fishery. The implementation of the pollock fishery under this allocation scheme may also have a detrimental effect on foraging of Steller sea lions or other protected species.

- *Authorization of a walleye pollock fishery under the Gulf of Alaska (GOA) groundfish FMP between 1999 and 2002*. Consultation on this fishery was initiated because the last completed consultation expires at the end of 1998, and this fishery may compete with Steller sea lions or other protected species.

This section of the opinion provides descriptive background information on the BSAI Atka mackerel fishery and pollock fisheries in the BSAI and GOA. For each species, sub-topics include the distribution and life history, trends in biomass, overview of the fishery (distribution of effort, methods, catch history, age-size-sex structure of the stock and the catch, bycatch), fishery management and the setting of harvest parameters (stock assessment and the stock assessment model, setting the TAC, allowance for other marine predators, and the action area (the extent of the area over which the fishery may exert either a direct or indirect effect).

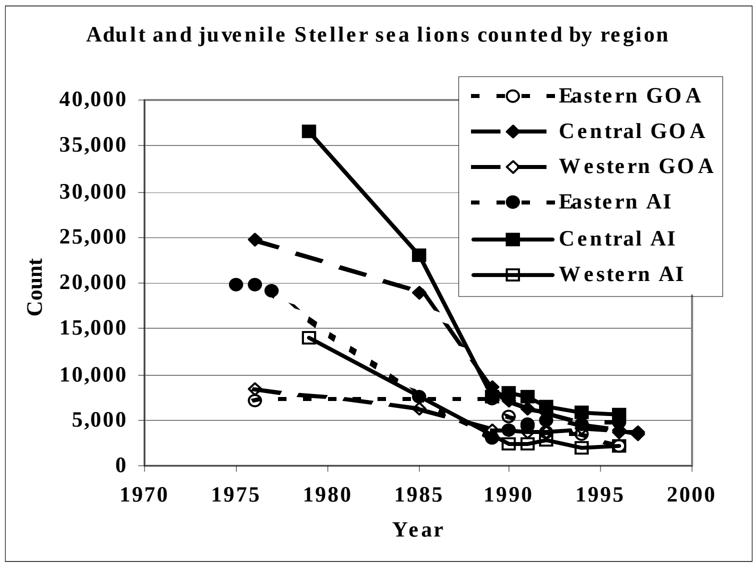
For the Atka mackerel fishery, a description is provided on the evidence of localized depletion. For the pollock fisheries, the inshore/offshore allocations are described. This descriptive information is generally available in Council documents such as the Stock Assessment and Fishery Evaluation (SAFE) documents or various environmental assessments (EA) prepared for management of the fisheries.

STATUS OF THE SPECIES

The purpose of this section is to describe the status of the Steller sea lion. Seabirds are considered in a separate biological opinion being conducted by the Fish and Wildlife Service. Salmon are being considered by the Northwest Regional Office, NMFS. Cetaceans were considered, but are not included further in the opinion as they were judged not likely to be adversely affected by the fisheries actions in question.

For Steller sea lions, the description includes the life history information (distribution, annual cycle, reproduction, survival, age distribution, foraging patterns [methods of study, foraging distributions, foraging depths, prey energetics and nutrition], natural predators and competitors, disease), population dynamics (biogeography, population status and trends, population variability and stability, population projections), and listed status. Critical habitat is described, with emphasis on the prey resources that comprise the most important biological features of critical habitat. In essence, the marine areas designated as critical habitat for the Steller sea lion were designated as such largely because they contain the prey resources necessary for the conservation of the species.

Of these descriptive subtopics, those on population status and trends, and on foraging patterns are probably the most important for the purposes of this consultation. With respect to population status and trends, the western population has declined by 80% or more throughout much of its range, and the latest counts indicate that the declining trend continues. Decreased juvenile survival appears to be a key element of the decline, although evidence from the 1970s and 1980s also indicates a decrease in reproductive effort.



Counts by region of adult and juvenile Steller sea lions in the western population.

With respect to foraging patterns, the opinion describes methods for studying Steller sea lions, a summary of their foraging distribution and depths, prey, and energetics and nutrition. The emerging picture suggests 1) Steller sea lions consume a variety of demersal and pelagic prey, 2) pollock and Atka mackerel are both important prey items, with varying importance for sea lions in different areas, 3) sea lion foraging patterns vary by size and sex class, 4) their foraging distributions vary by season, 5) for the animals in the initial studies, the majority of their dives appear to be relatively shallow, 6) their prey requirements likely vary by season, 7) intraspecific competition may be limited by dispersal of adult males and females during the non-reproductive part of the year and by wide dispersal of juveniles after weaning, 8) nearshore waters may be particularly important during the reproductive season when lactating females are limited by the nutritional requirements of their pups, 9) the transition by young animals from dependence on their mothers to independent feeding may require months to years, and 10) diversity of prey may be essential to population stability and growth.

ENVIRONMENTAL BASELINE

The environmental baseline is intended to provide a discussion of how the Steller sea lion came to be at its current status. The baseline considers factors that are related to human activities and those that are not.

“Natural” factors include predation, disease, and environmental changes. Human-related factors include commercial harvesting, subsistence harvesting, fisheries impacts (Federal and State; including incidental take and intentional take), entanglement in marine debris, toxic substances, disturbance, research activities, and oil, gas, and mineral development. This section also includes a section on Federal fishery management actions already implemented.

A variety of factors have influenced the past trends of the western population, and those factors can and have changed over time. That is, no single factor can account for the entire decline. Evidence that one factor was influential does not rule out the possibility that other factors were also operating. Disease has the potential to cause a major decline but, to date, the available information does not link the decline to disease, and the geographically expansive and long-lived nature of the decline is not consistent with the expected expression of a major disease problem. In the 1970s and 1980s, incidental take accounted for the loss of a significant number of animals, but is no longer a significant problem. Intentional take is a matter of concern but can not be quantified at this time. Intentional take may still be a problem, although it is not expected to be as high as suggested for previous years. The commercial harvest of pups must have contributed to the decline of local populations where the harvests occurred, but does not explain the full long-term decline at those sites or the decline observed in other areas. Entanglement rates are relatively low for Steller sea lions and are not thought to be a problem. Increased predation has been suggested as a possible explanation for the decline, but this suggestion is supported only by very limited anecdotal data. Pollution may reduce reproduction or survival of sea lions, but the only scientific findings to date pertain to observed levels of various pollutants in the tissues of sea lions. Harassment has likely occurred in many areas and may have been very disruptive to sea lion colonies on rookeries or haulouts, thereby leading to redistribution of animals. Nevertheless, harassment is thought to be less common at present, and the data are not sufficient to demonstrate that harassment was a significant contributor to the decline. Harassment is also a less likely explanation in the remote areas of the sea lion range, where declines have been observed (e.g., central and western Aleutian Islands).

Climatic and oceanographic changes may have contributed significantly to the decline of Steller sea lions. Such changes could lead to reduced productivity to support prey populations, changes in community structure and composition, or changes in availability of prey species (i.e., all contributing to changes in carrying capacity). Since the late 1980s, considerably more information has become available on atmospheric and oceanographic changes in the Bering Sea and North Pacific, and this information provides evidence that some observed changes in community structure were related to changes in physical conditions in these ecosystems.

The hypothesis that lack of available prey may have contributed to the decline is based on studies of animals collected in the GOA in 1975-1978 and 1985-1986. These studies indicate changes in growth, condition, reproduction and survival - all findings consistent with nutritional stress. Additional studies also indicate a decline in juvenile survival. On the basis of this information, coupled with information on extensive trophic shifts in the BSAI and GOA regions, and the expansion of these fisheries, lack of available prey has become the leading hypothesis for the decline of the Steller sea lion.

EFFECTS OF THE ACTION

This section provides the analysis on which the conclusion of the opinion is based. The purpose of this section is to describe the direct, indirect, interdependent, and interrelated effects of the fisheries actions to determine if those fisheries, as implemented, may jeopardize the continued existence of the Steller sea lion or adversely modify its critical habitat.

The biological opinion begins by considering factors that are common to all three fisheries. Those factors, and a brief description of the major points, are as follows.

Uncertainty and risk

Much of the information in the opinion describes what we don't know about the problems being evaluated, as well as what we do know. The point is that the opinion will end with a conclusion based on the best available scientific and commercial data available, and it is important to recognize the strengths and weaknesses of that data in helping explain the Steller sea lion situation. There are risks associated with either conclusion (jeopardy or adverse modification versus no jeopardy or adverse modification). Those risks include a Type I error in which we might falsely conclude that the fisheries have a greater impact than they do, and a Type II error in which we falsely conclude that the fisheries do not have a significant impact when, in fact, they do. Any consideration of risks associated with the conclusions of this document should reconcile both of these types of errors.

Potential fisheries effects

Fisheries effects on marine mammals are generally split into operational effects (entanglement in gear, gear destruction, incidental catch or kill, etc.) and biological effects (competition for prey, changes to the size/age distribution of the target or prey species, changes to ecosystem composition, or disturbance of foraging patterns). This section of the report focuses on biological effects, as the information available suggests that operational effects are negligible at the population level.

The primary consideration is whether competition occurs between Steller sea lions and these three fisheries. We know that the fisheries operate in the areas where sea lions forage (e.g., critical habitat). We know that fisheries and sea lions consume both pollock and Atka mackerel, and the information in the opinion indicates that the sizes of pollock taken by sea lions overlaps with the sizes taken by the fishery. We also suspect that sea lions are limited by lack of available prey (as discussed above).

We are unable to describe in detail the nature and magnitude of the any competition that may occur between sea lions and the fishery (i.e., we are unable to determine if a "link" exists) because we are unable to describe the predator-prey dynamics of sea lions and Atka mackerel or pollock. Nevertheless, such links may exist. The opinion discusses two approaches to defining those links, and reasons why those approaches may have failed. In statistical and research terms, our investigative methods lack the power to detect significant links if they exist.

Diversity

The issue of diversity is discussed in two contexts. The first is the recent information suggesting that sea lion trends in 1990-1993 were related to diversity of prey taken. The results suggest that a diversity of prey is important for sea lions to recover. The second context pertains to the question of whether the pollock fisheries, in particular, may have played a past role in the trophic shift observed in the BSAI and GOA regions, or whether it may be a determinant of the future composition of these ecosystems.

Prey quality

Prey quality has become an issue in the Steller sea lion - fisheries debate largely because of the hypothesis suggested by Alverson (1991) that the shift from an ecosystem with a diversity of forage fishes to one dominated by pollock has reduced the quality of prey available to sea lions and may explain their decline. This hypothesis has become known as the "junk food hypothesis," although Alverson did not use that term. The implications of prey quality for sea lions are discussed in the context of this opinion and the information available on their diet.

Sensitivity to change, resilience, and recovery rate

The potential effects of fisheries on Steller sea lion are a function not only of the fisheries actions, but also of the characteristics of sea lions. In attempting to facilitate the recovery of this species, management must consider the ability of sea lions to tolerate various kinds of perturbation. The facts that the species has been declining for at least two decades without explanation and that we are unable to predict their trends even next year indicates that we do not understand their sensitivity to change. Resilience refers to their ability to recover when the perturbation has subsided and here, too, we know little about their resilience. Based on life history information, we can conjecture (with considerable confidence) that they are not likely to recovery at more than 10% per year, even under the best of conditions. This kind of information is important in providing a perspective on the nature and longevity of the recovery effort.

The winter season

The winter season has been a topic of considerable debate on matters related to the life history of Steller sea lions. The issue is whether the winter season is a period of particular sensitivity to change, particularly in food availability. The information available argues in an absolute sense, winter is a critical period, especially for adult females and young-of-the-year or juveniles. In a relative sense, however, similar arguments could also be made that other seasons are also crucial for a number of reasons. Winter is likely a crucial period, but food availability is necessary year round.

Adverse modification of critical habitat

The requirements of the Endangered Species Act (and section 7 in particular) are that the consultation consider not only the potential for an action to jeopardize the continued existence of a species, but that it also consider the potential for the action to destroy or adversely modify the habitat that has been designed as critical for that species. While these two considerations are not always the same, they are closely related in the case of potential fisheries interactions with Steller sea lions. Reduction in the prey available to food-limited sea lions through fishery removal of that prey constitutes competition, and also diminishes the value of the most important biological feature of critical habitat, its prey base. That prey base should be sufficient to support healthy, recovered sea lion populations.

Predator-prey dynamics, fishery effects, and links

Much of the uncertainty involved in this issue results from our poor understanding of predator-prey dynamics and the influence of fishing activities on those dynamics. Our current understanding of sea lions and their prey is progressing, but still rudimentary. Such uncertainty will likely persist into the near future. The lack of information neither proves nor disproves competition between sea lions and fisheries.

Scale and potential fishery effects

The issue of scale is fundamental to consideration of potential fisheries effects on sea lions. Management of the fisheries is intended to be conservative with respect to target species and the entire ecosystem. Nevertheless, fishery management parameters such as the total allowable catch, the overfishing level, and the overall harvest rate are generally evaluated on a stock-wide basis. This is consistent with the so-called "single-species" approach, and when combined with accurate and reliable stock assessment methods may be considered a useful approach to the management of the target species. However, additional constraints are placed on fisheries to take into account the potential for ecosystem effects that may result from excessive localized depletion or excessive bycatch (particularly of prohibited species). Time-area measures are used to disperse fishing effort and catch and prevent concentration of detrimental effects in time or space. The use of management areas and seasons are examples of time-area measures. Closed areas are also used to prevent detrimental effects either on the target species in certain parts of its range (e.g., areas closed to herring fishing) or to prevent detrimental effects on other components of the ecosystem (e.g., protective no-trawl zones around Steller sea lion rookeries). The purpose of these measures is to scale the potential detrimental effects of fishing that may be caused by concentrated harvesting to the tolerance of either the target species or other elements of the ecosystem.

Effects specific to each of the three fisheries

Evaluation of each of the three fisheries indicates that they may lead to detrimental effects due to concentration of effort either in time or space. The Atka mackerel fishery has been concentrated spatially and temporally with 70% or more of its total catch coming from Steller sea lion critical habitat, and the majority of the catch coming in January to March or April. The Council voted in June to disperse this fishery by establishing two seasons and reducing the percent of TAC caught in critical habitat to 40% in areas 542 and 543 over the next 4 years.

The BSAI pollock fishery has become concentrated in time and space. Since 1990, the fishery has gone from nearly 10 months per year to about 3 months or less in recent years. Much of that effort is focused in the winter months (Fig. 3). The fishery has also become concentrated in Steller sea lion critical habitat (Figs. 1, 4), which overlaps considerably with the catcher vessel operation area (CVOA; Figs. 5,6). Removal rates from the CVOA during the B season have approached 50% in 1997, and in the four years when harvest rates could be estimated (1991, 1994, 1996, 1997), those rates in the B season CVOA exceeded overall harvest rates by at least a factor of 2. Similar rates can not be calculated for other years or for the A season because survey information is not available for those years, particularly in the winter or A season. Pollock are thought to be aggregated for spawning in the late winter, but without survey information, the potential for concentrated harvesting can not be evaluated.

The GOA pollock fishery is more dispersed in time than the GOA pollock fishery (Fig. 3), but has been concentrated in Steller sea lion critical habitat since the discovery of the pollock spawning aggregation in Shelikof Strait in the early 1980s (Figs. 2, 4). Since 1982, 50% to 90% of the pollock catch has come from critical habitat. If the fish stock is distributed such that 50% to 90% of the stock is located within critical habitat, then such harvesting may not be concentrated relative to the stock distribution, and may therefore be less likely to have detrimental ecosystem effects. In the GOA, harvest rates in most areas can not be calculated as the survey information is not available to determine the distribution of stock biomass.

CONCLUSION

The information and analyses in the biological opinion are required to determine if the fisheries, as implemented, are reasonably likely to either jeopardize the continued existence of the western population of Steller sea lion or destroy or adversely modify its critical habitat. The Regional Administrator for the Alaska Region will make his recommendation to the Chief of the Office of Protected Resources, who is responsible for the final decision. The decision is not final until signed by the Chief of the Office of Protected Resources. The opinion is expected to be signed on or before December 16, 1998.

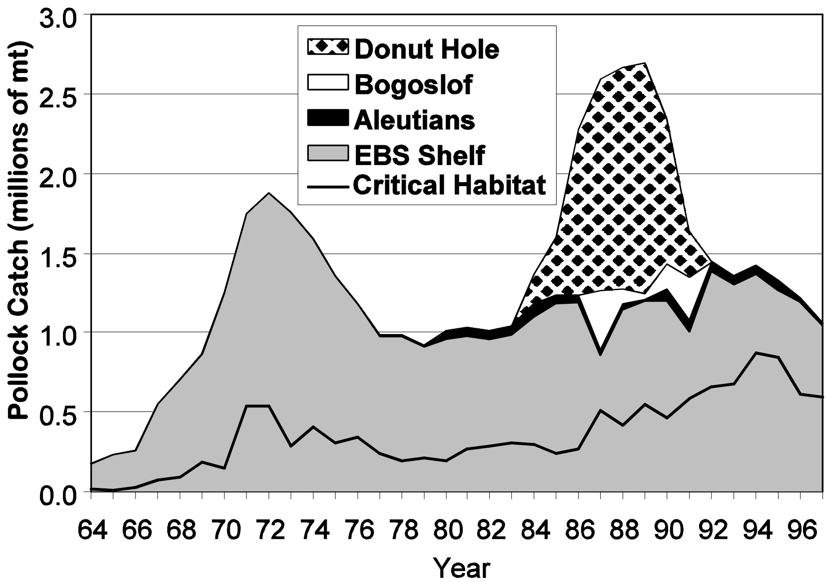


Figure 1. Catch of walleye pollock (mmt) in the eastern and central Bering Sea and Aleutian Islands from 1964 to 1997. Catch of pollock is shown in the following regions: (1) the Donut Hole, or international waters outside of the US EEZ in the central Bering Sea; (2) Bogoslof Island area in the US EEZ, a spawning area for the Donut Hole stock; (3) Aleutian Island area west of 170° W longitude and south of 55°N latitude in the US EEZ; (4) eastern Bering Sea (EBS) shelf, and (5) Steller sea lion critical habitat within the Bering Sea/Aleutian Island region. Regions 2-4 above sum to the total BSAI pollock catch within the US EEZ, while the catch within critical habitat is a portion of this total.

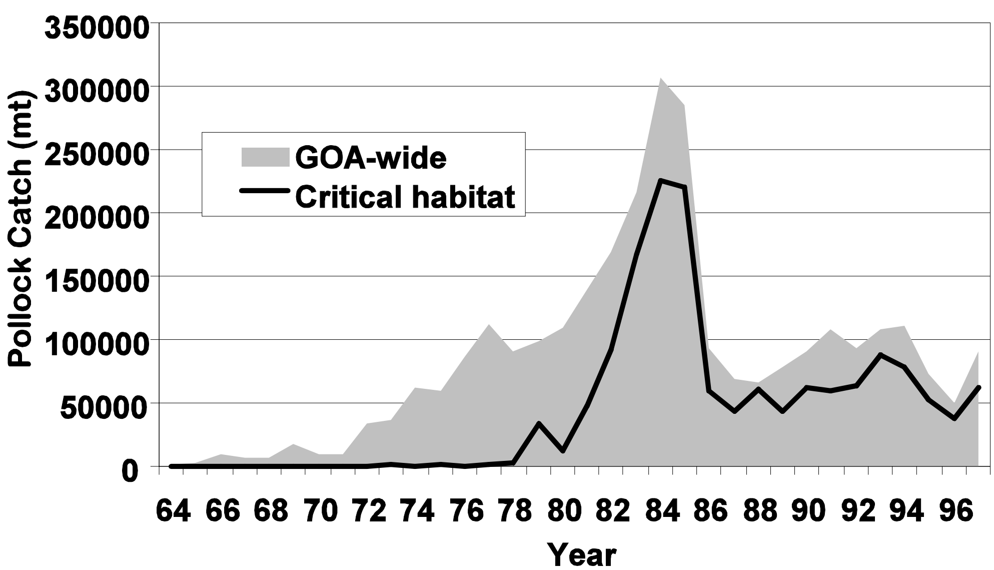


Figure 2. Catch of walleye pollock (mt) in the GOA and in GOA Steller sea lion critical habitat from 1964 to 1997.

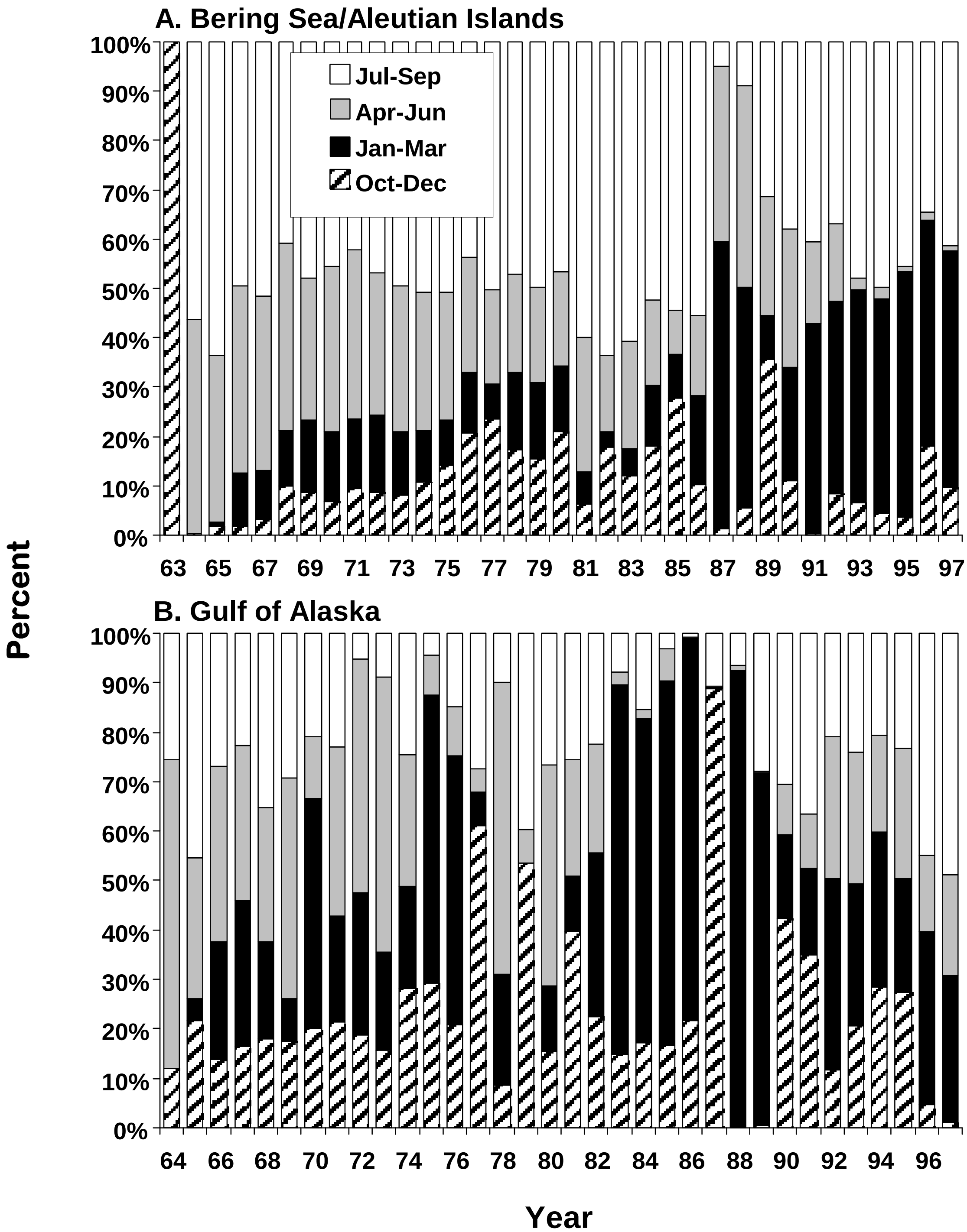


Figure 3. Quarterly distribution of pollock catch in the eastern Bering sea and Aleutian Islands (A) and the GOA (B) from 1963 to 1997.

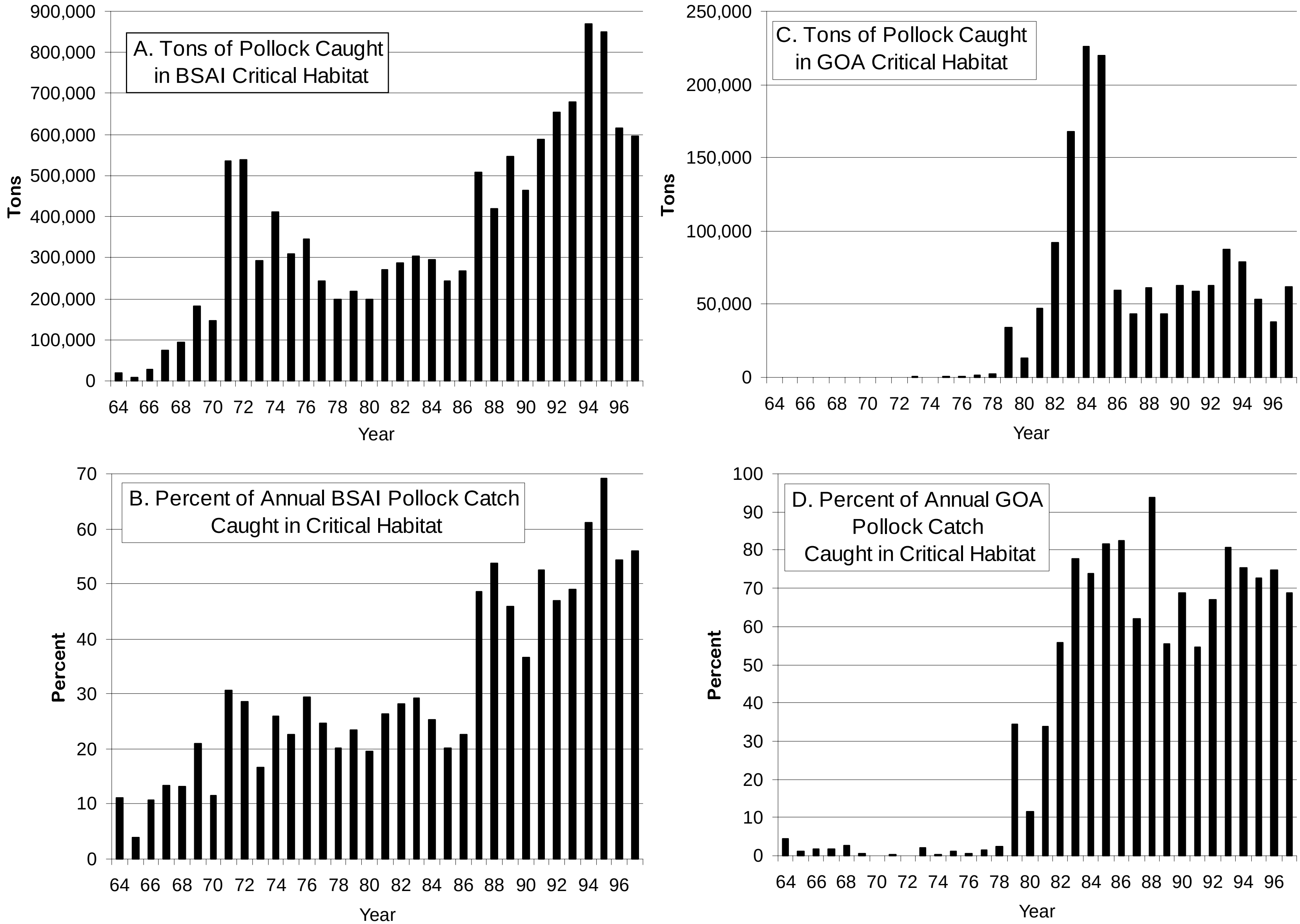


Figure 4. Catch (tons; A and C) and percent of annual regional catch of pollock (B and D) from Steller sea lion critical habitat in the BSAI (A and B) and GOA (C and D) from 1964 to 1997.

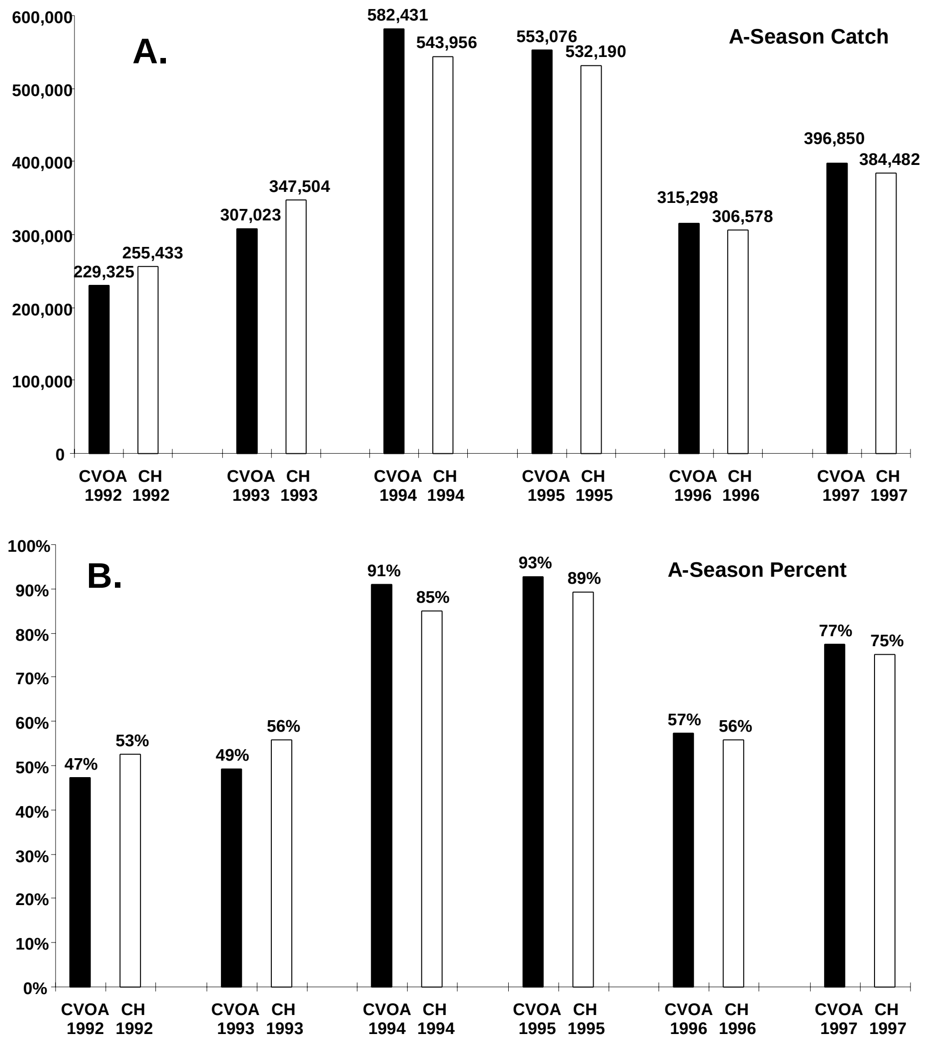
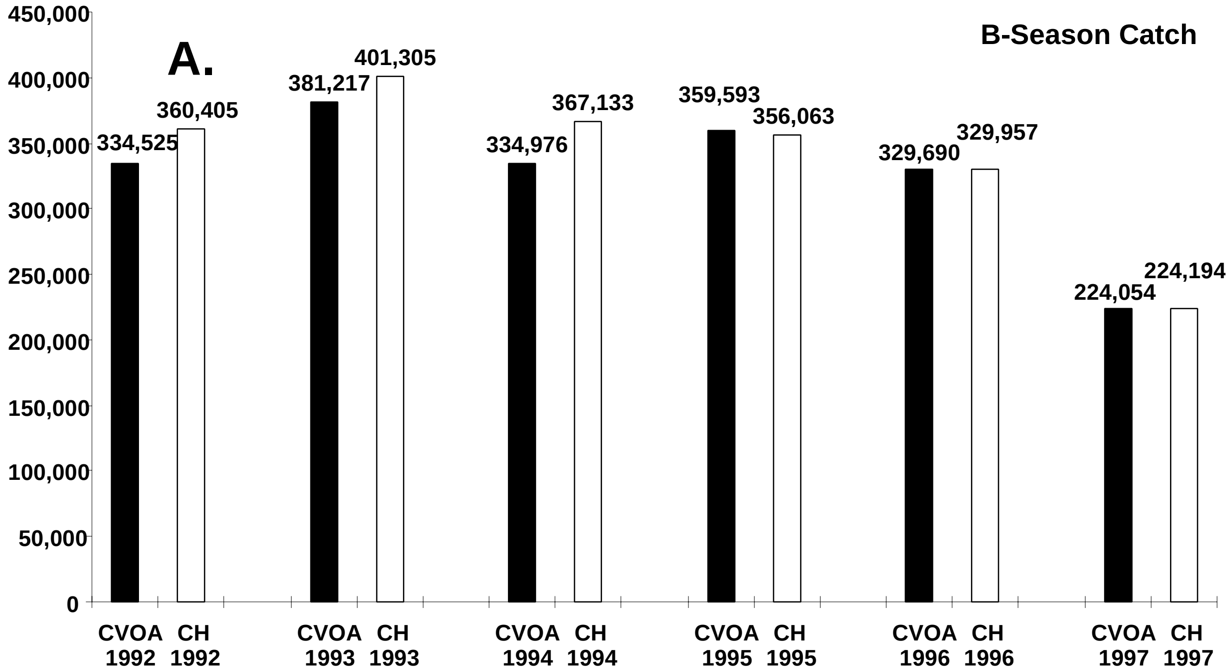


Figure 5. A-season catches (A; in mt) of pollock in the BSAI in 1992 to 1997 in the Catcher Vessel Operational Area (CVOA) and in Steller sea lion critical habitat. Percent of total A-season BSAI pollock catch is shown in B.



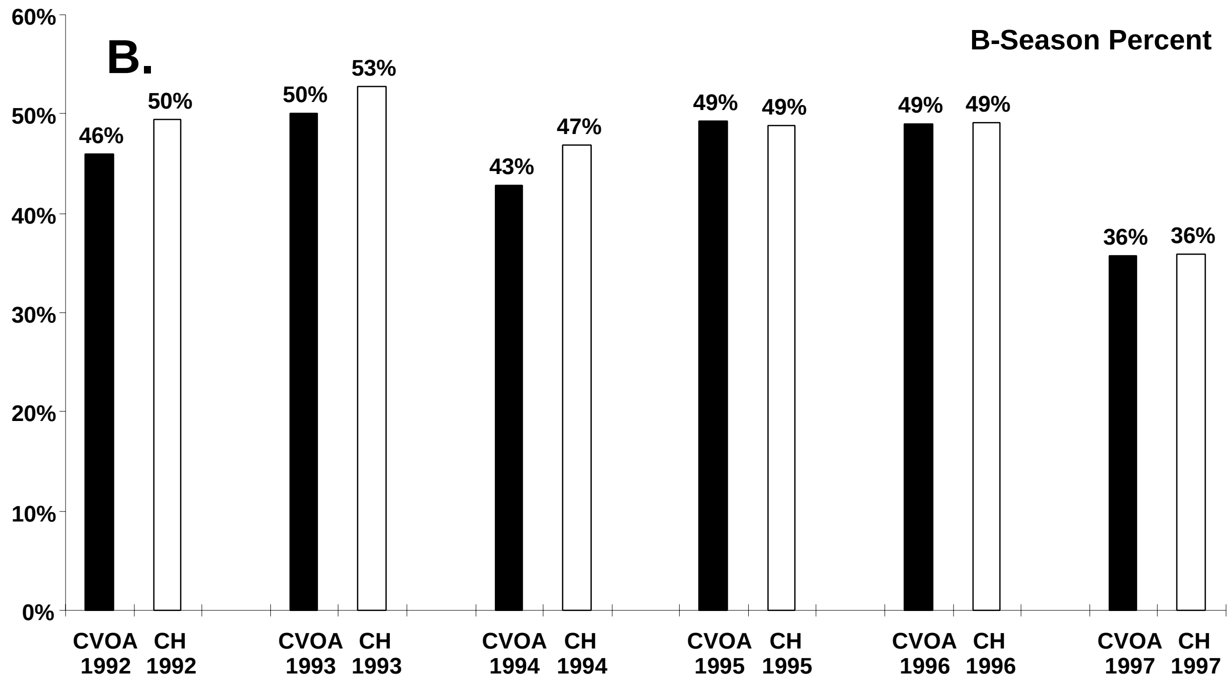


Figure 6. B-season catches (A; in mt) of pollock in the BSAI in 1992 to 1997 in the Catcher Vessel Operational Area (CVOA) and in Steller sea lion critical habitat. Percent of total B-season BSAI pollock catch is shown in B.

OCEANOGRAPHIC CHANGES IN 1997/98
by Jane DiCosimo

The 1997 Ecosystems chapter contained a description of oceanographic effects on North Pacific groundfish, including El Nino, the southern oscillation, and the Sitka gyre. A review of oceanographic and climate data from the North Pacific and Bering Sea by Hollowed et al (1998) revealed events that occur on three principal time scales: (a) 1-5 years (El Nino Southern Oscillation and interannual variation), (b) 6-12 years (decadal scale variability), and (c) 30 years (Pacific decadal oscillation, PDO). This section will update information on the 1998 El Nino event, La Nina, and the 1998 coccolithophore bloom in the Bering Sea.

1998 El Nino Southern Oscillation

As described on the NOAA web site (http://www.elnino.noaa.gov) El Niño (EN) is characterized by a large scale weakening of the trade winds and warming of the surface layers in the eastern and central equatorial Pacific Ocean. El Niño events occur irregularly at intervals of 2-7 years, although the average is about once every 3-4 years. They typically last 12-18 months, and are accompanied by swings in the Southern Oscillation (SO), an interannual see-saw in tropical sea level pressure between the eastern and western hemispheres. During El Niño, unusually high atmospheric sea level pressures develop in the western tropical Pacific and Indian Ocean regions, and unusually low sea level pressures develop in the southeastern tropical Pacific. SO tendencies for unusually low pressures west of the date line and high pressures east of the date line have also been linked to periods of anomalously cold equatorial Pacific sea surface temperatures (SSTs) sometimes referred to as La Niña.

Surface waters of the Gulf of Alaska have been warming over the last few decades, with the warmest temperatures recorded in 1994 (Whitney et al. 1998a). Temperatures off British Columbia in the summer of 1997 were warmer than previous temperature maxima by 1° C. A thinning of the mixed layer has been accompanied by a reduction in the nutrient supply, abnormally low chlorophyll layers, and substantial reduction in primary production in late summer (Wheeler and Hill 1998; Whitney et al. 1998b). This reduction has substantial potential to impact fish stocks.

There is evidence of reversals in the prevailing polarity of the oscillation occurring around 1925, 1947, and 1977; the last two reversals correspond with dramatic shifts in salmon production regimes in the North Pacific Ocean.

This climate pattern also affects coastal sea and continental surface air temperatures, as well as streamflow in major west coast river systems, from Alaska to California (Mantua et al. 1997). Pacific salmon catches in Alaska have varied inversely with catches from the United States West Coast during the past 70 years (Hare et al. in press). The spatial and temporal characteristics of this "inverse" catch/production pattern are related to climate forcing associated with the Pacific Decadal Oscillation. From

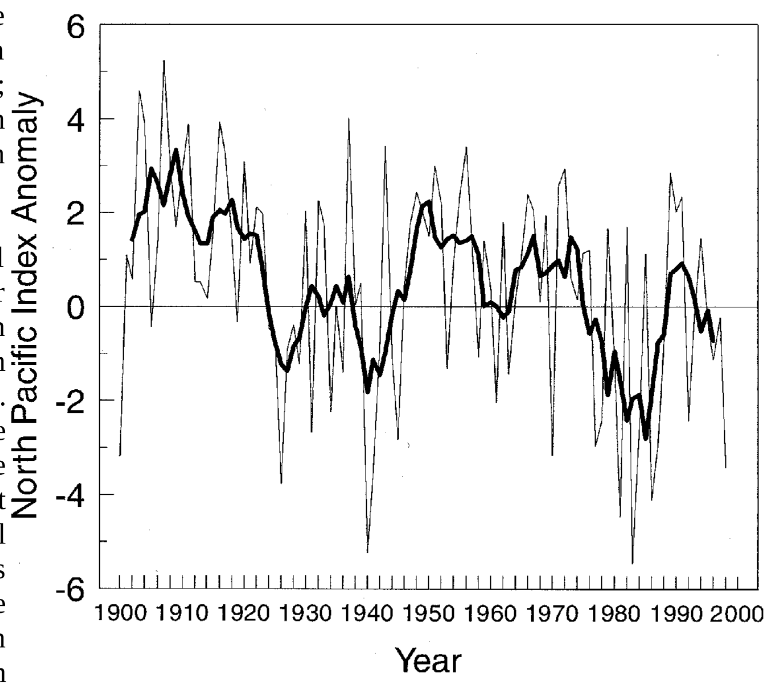


Figure 1.

1977 to the early 1990s, ocean conditions have generally favored Alaska stocks and disfavored West Coast stocks. Unfavorable ocean conditions are likely confounding recent management efforts focused on increasing West Coast Pacific salmon production. Recovery of at-risk (threatened and endangered) stocks may await the next reversal of the Pacific Decadal Oscillation.

Decadal changes in salmon productivity have been related to indices of the strength of the Aleutian Low in winter, which may affect feeding success during early marine life (Kruse 1998). A North Pacific Index indicates variability in the strength in the Aleutian Low (Figure 1).

A very close linkage has been established between changes in oceanic conditions driven by Aleutian Low variability and Alaskan salmon production (Hare and Francis 1992, Beamish and Bouillon 1993, Francis and Hare 1994, Hare and Francis 1995, Hare 1996). The historical variability in catches of the major Alaskan salmon stocks and the proposed regime changes in production levels is illustrated in Figure 2.

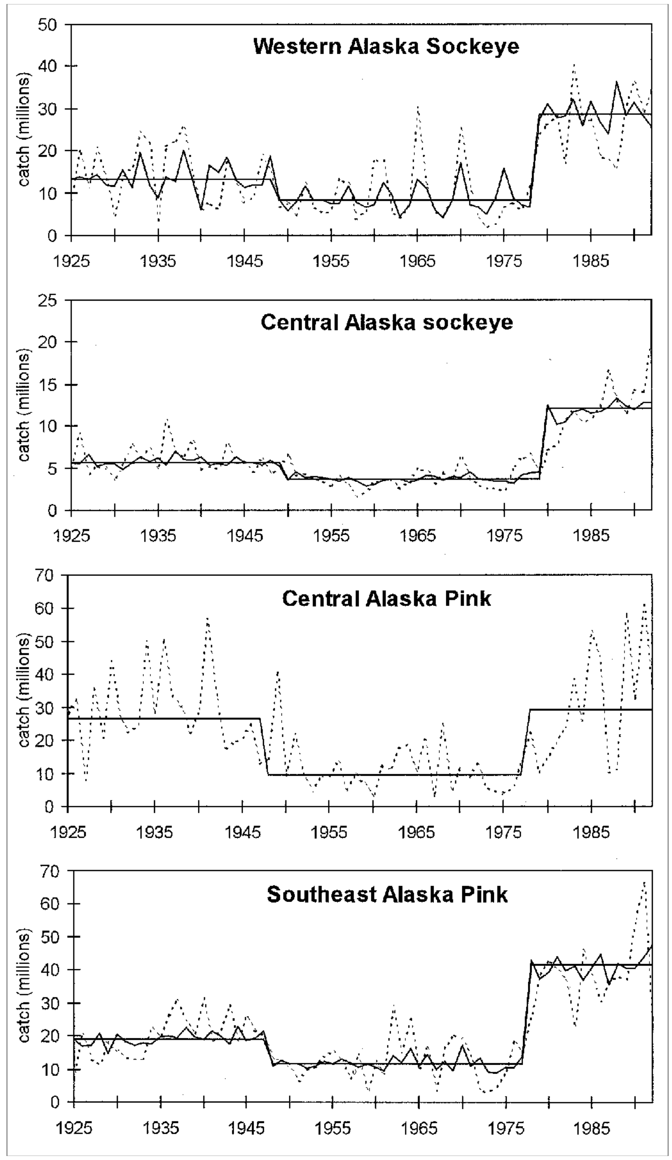


Figure 2. Time history of catches (dashed line), intervention model fits (thin solid line), and estimated interventions (thick solid lines) for the four major Alaska regional salmon stocks. From Francis and Hare (1995).

Analysis of return-per-spawner data is needed to determine whether this climate-salmon relationship continues to hold. Additionally, significant changes in ocean conditions occurred in the North Pacific and Bering Sea in 1997/98 that may have had profound effects on the marine ecosystem. Not only was there a very strong equatorial El Niño, but light winds, low nutrients, and high solar radiation led to the first-recorded bloom of coccolithophores in the Bering Sea in summer 1997 and a second bloom in spring 1998 (Kruse 1998). Brodeur et al. (1998) reported that a possible regime change occurred beginning around 1990 resulting in a ten-fold increase in median biomass of large medusae (jellyfish) in the eastern Bering Sea. Kruse (1998) reported a number of anomalous sightings: Pacific white-sided dolphins (*Lagenorhyncus obliquidens*) were seen between Southeast Alaska and the northern GOA; an albacore (*Thunnus alalunga*) fishery developed off Kodiak Island; the offshore walleye pollock (*Theragra chaclogramma*) fishery shifted its fleet 1.5 times farther north in the Bering Sea; northern anchovies (*Engraulis mordax*) were reported in the stomachs of salmon caught off Yakutat; a yellowfin tuna (*Thunnus albacares*) and several sunfish (*Mola mola*) were seen in the northern Gulf. Kruse (1998) also reported a number of first time records also occurred: Pacific herring (*Clupea pallasi*) spawned earlier than every before in Sitka Sound and a coccolithophore (*Emiliania huxleyi*) bloom occurred in the eastern Bering Sea.

As described in Francis et al. (unpubl.), between 1950 and 1984, Hollowed and Wooster (1992, 1995) were able to show a linkage between the timing of cool and warm eras and years of simultaneous strong year classes in 15 groundfish stocks ranging from California to the Bering Sea (1961, 1970, 1977 and 1984) (Figure 3**)**. Each of these years occurred during a warm era when Type B circulation prevailed and three of the four years were associated with El Niño events. Hollowed and Wooster (1995) suggest that the relationships between climate forcing and marine biological response at higher trophic levels are not as clear as those at lower trophic levels. They speculate that ocean conditions associated with warm temperature may be a necessary but not sufficient condition for strong year classes in NE Pacific marine fishes. And in that strong year classes tend to occur infrequently, their findings suggest that in iteroparous species with moderate life spans, changes in stock abundance associated with decadal-scale climate variability may be associated with the "storage effect" of a few exceptionally strong year classes (Chesson 1984).

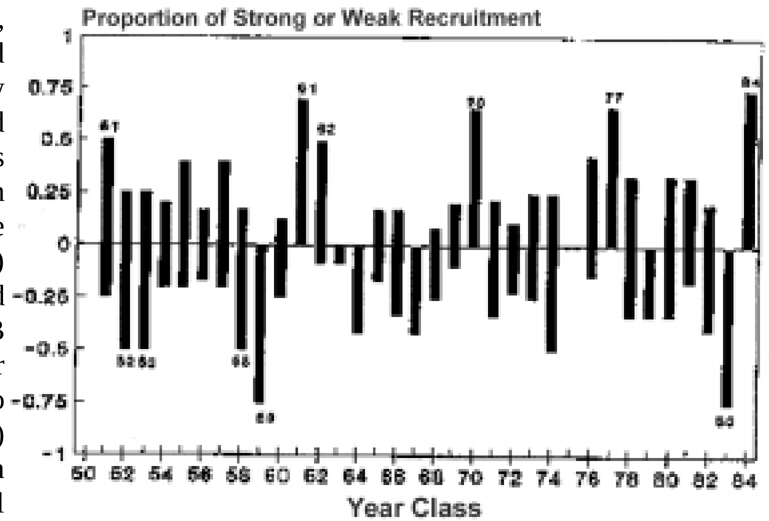


Figure 3.

La Niña

La Niña is defined as cooler than normal sea-surface temperatures in the tropical Pacific ocean that impact global weather patterns. La Niña conditions may persist for as long as two years. El Niño and La Niña are extreme phases of a naturally occurring climate cycle referred to as El Niño/Southern Oscillation. Both terms refer to large-scale changes in sea-surface temperature across the eastern tropical Pacific. Usually, sea-surface readings off South America's west coast range from the 60s to 70s F, while they exceed 80 degrees F in the "warm pool" located in the central and western Pacific. This warm pool expands to cover the tropics during El Niño, but during La Niña, the easterly trade winds strengthen and cold upwelling along the equator and the West coast of South America intensifies. Sea-surface temperatures along the equator can fall as much as 7 degrees F below normal.

El Niño and La Niña result from interaction between the surface of the ocean and the atmosphere in the tropical Pacific. Changes in the ocean impact the atmosphere and climate patterns around the globe. In turn, changes in the atmosphere impact the ocean temperatures and currents. The system oscillates between warm (El Niño) to neutral (or cold La Niña) conditions with an on average every 3-4 years. Both El Niño and La Niña impact global and U.S. climate patterns. In many locations, especially in the tropics, La Niña (or cold episodes) produces the opposite climate variations from El Niño. For instance, parts of Australia and Indonesia are prone to drought during El Niño, but are typically wetter than normal during La Niña.

The latest NOAA ocean-atmosphere model (July 1998) indicate strengthening cold episode conditions in the tropical Pacific during the remainder of 1998. Other statistical and coupled-model forecasts indicate a similar evolution. The consistency among the available predictions together with the evolution of oceanic and atmospheric conditions since early May indicate that a cold episode is developing and will likely continue through the northern 1998-99 winter. The current forecasts indicate that the 1998/99 La Niña will be a moderate to strong episode. Greater than normal precipitation is predicted for the Pacific Northwest throughout the fall and into the winter months

The Southern Oscillation Index (SOI), defined as the normalized difference in surface pressure between Tahiti, French Polynesia and Darwin, Australia is a measure of the strength of the trade winds, which have a component of flow from regions of high to low pressure. High SOI (large pressure difference) is associated with stronger than normal trade winds and La Niña conditions, and low SOI (smaller pressure difference) is associated with weaker than normal trade winds and El Niño conditions. The terms ENSO and ENSO cycle are used to describe the full range of variability observed in the Southern Oscillation Index, including both El Niño and La Niña events.

There has been a confusing range of uses for the terms El Niño, La Niña and ENSO by both the scientific community and the general public. Originally, the term El Niño (in reference to the Christ child) denoted a warm southward flowing ocean current that occurred every year around Christmas time off the west coast of Peru and Ecuador. The term was later restricted to unusually strong warmings that disrupted local fish and bird populations every few years. However, as a result of the frequent association of South American coastal temperature anomalies with interannual basin scale equatorial warm events, El Niño has also become synonymous with larger scale, climatically significant, warm events. There is not, however, unanimity in the use of the term El Niño. The tendency in the scientific community though is to refer interchangeably to El Niño, ENSO warm event, or the warm phase of ENSO as those times of warm eastern and central equatorial Pacific SST anomalies. Conversely, the terms La Niña, ENSO cold event, or cold phase of ENSO are used interchangeably to describe those times of cold eastern and central equatorial Pacific SST anomalies. The terms “El Viejo” and “anti-El Niño” have also been applied to the cold phase of ENSO. However, these terms are used less frequently, as the term La Niña has gained currency.

In the late 1970s, a regime shift occurred in the climate of the North Pacific causing many shifts, including a 5% reduction in the ice cover in the eastern Bering Sea and shifts in the position of the Aleutian low. Since the regime shift (1978-95), increases in ice are now associated with El Nino events compared with increases in ice during and following La Nina events before the shift. Before the regime shift, the occurrence of El Nino and La Nina conditions was about even. Since then, El Nino conditions are about three times more prevalent (Niebauer 1998c).

The 1997/98 El Niño event catapulted in status to become one of the strongest events on record. El Nino began at the equator in April 1997 and ended by late April 1998. During the winter of 1997/98, the Aleutian low was more intense and eastward of normal in teleconnection with the Southern Oscillation. In November 1997 and March 1998, the Aleutian low was directly over the Bering Sea causing strongly below normal ice conditions in November and slightly below normal ice conditions in March and April. From December to January, however, the low moved so far to the east that winds over the Bering Sea were from the northeast resulting in above normal ice conditions as well as colder than normal air and sea temperatures under abnormally cool winds (Niebauer 1998a). The largest temperature anomaly in the GOA (more than 3 standard deviations above the norm) peaked in February 1998, with the first warming occurring in January 1998, but had subsided to below normal by May 1998 (Royer and Weingartner 1998).

Coccolithophore bloom and its effects on other living marine resources

The following is a summary by Vance et al. (1998) of the coccolithophore bloom that covered most of the continental shelf of the eastern Bering Sea for months during 1997 and 1998. The bloom turned the water an aquamarine color due to light reflecting off the calcium carbonate plates of the flagellated coccolithophores. This depleted light penetration in the water column, and consequently reduced primary production by diatoms and other phytoplankton. The change in primary producers may have altered the trophic dynamics throughout the food web. Prior to and during the bloom, anomalous atmospheric and oceanic conditions were evident. In July 1997, large whales were relatively abundant in the region of the middle shelf where the bloom occurred. Concomitant with the coccolithophore bloom were die-offs of seabirds and a decrease in the number of salmon returning to Bristol Bay. Reports of die-offs of seabirds began in early August.

A sequence of unusual phenomena occurred in the coupled atmosphere-ice-ocean system in 1997 which may have favored rapid growth of the coccolithophores. Winter sea-ice conditions exhibited average areal and latitudinal extent but meltback appeared to be unusually rapid. In spring and summer, there were reduced numbers of energetic storms and anomalously cloud free conditions. One consequence was that greater stratification than usual occurred over the shelf. Sea surface temperatures were up to 3° C above normal in June. The decrease in storms and clouds resulted from atmospheric connections to the current El Nino occurring in the equatorial Pacific. The warm waters were not due to a direct oceanic connection to the ongoing El Nino.

The first observation of the bloom occurred in early July, when the normal summer phytoplankton community had probably been replaced by coccolithophores. Characteristic of these blooms are surface waters that have high reflectance, and low chlorophyll and particulate organic carbon concentrations. Light penetration and visibility in the aquamarine waters were markedly reduced. By September, the areal extent of the bloom was 700 x 300 km. The vertical extent of the bloom, based on underwater video observations made in September, varied from a thin layer to a layer up to 50 m deep. In some areas near shore the layer extended to the seafloor. At that time the bloom had been evident for two months which is longer than most recorded blooms.

The conditions near the inner front off Cape Newenham provide an example of the abnormal conditions. In June, nitrogenous nutrients were depleted from the bottom layer of the middle shelf, and the inner front was not well developed. Short-tailed shearwaters (*Puffinnus tenuirostris*), however, were eating their normal diet of adult euphausiids and had normal body weights. In mid-July, densities of seabirds were lower in the eastern edge of the aquamarine waters of outer Bristol Bay. In general, however, the condition and behavior of pelagic seabirds were normal during July. Large feeding flocks of short-tailed shearwaters were observed on the middle shelf. By the first week of August, coastal die-offs of birds were reported. During the late summer and early fall, a major die-off occurred with thousands of dead birds washing ashore. In the fall, observations near the Pribilof Islands and off Nunivak Island substantiated the reports. Corpses of birds were conspicuous in areas affected by the bloom.

Both dead and living shearwaters had significantly reduced body mass compared to birds collected in June, indicating starvation. In addition to the typical diet for shearwaters of euphausiids in Bristol Bay, fish and squid were being ingested. Those birds ingesting euphausiids were preying upon the smaller juvenile stages. Also, foraging shearwaters appeared to avoid areas with aquamarine water (both around the inner fronts and at the Pribilof Islands), where they may have had difficulty in detecting and capturing prey under the existing low underwater light conditions. Given the observations to date, starvation appears to be the prime cause of the shearwater die-off.

Other changes were evident in the ecosystem. The Bristol Bay salmon run was at least 15 million fish below predictions. Evidence from a test fishery at Port Moller suggests that the fish were dying on their way to Bristol Bay. Salmon were found to be more common in the diets of the northern fur seal that in previous years. Redistributions of some species of whales in the southeast Bering Sea may have occurred, but there are few large-scale synoptic surveys of cetaceans available for comparison during the past 20 years. During July, five species of large whales - humpback whales (*Megaptera novaeangliae*), fin whales (*Balaenoptera physalus*), sei whales (*B. borealis*), minke whales (*B. acutorostrata*), and right whales (*Eubalaena glacialis*) and harbor porpoises (*Phocoena phocoena*) were observed either in or near the coccolithophore bloom on the middle shelf (Tynan 1998). This suggests that the bloom and adjacent waters provided productive foraging for cetaceans and their prey. Comparison of this year with more normal years in the future will be needed to confirm the changes in feeding behavior.

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ANECDOTAL INFORMATION FROM 1998

by Ivan Vining

This year there were some warm water species in the Gulf of Alaska (GOA), along with some other stray fish, marine mammals and birds. Two Pacific barracuda (*Sphyraena argentea*) were caught in the Valdez Arm of PWS in the beginning of July by a pink salmon purse seine, F/V Western Sea, fished by James Barclay. Similarly, in Old Harbor on Kodiak Island a fisherman caught a Pacific barracuda in July. Finally, near Haines, some fishermen caught Pacific barracuda. Ocean sunfish (*Mola mola*) were seen in mid-August in Resurrection Bay (near Seward). Several of these large fish were also spotted near Ketchikan. Many (thousands of pounds) chub mackerel (*Scomber japonicus*) were also caught near Ketchikan in late July thru early September. These mackerel were also caught near Haines by Bill Thomas a local driftnet fisherman. Both the ocean sunfish and chub mackerel may not be that uncommon in southeast Alaska (Hart 1973), however the quantities documented were considered unusual. Similarly, Pacific sleeper sharks (*Somniosus pacificus*) were caught (and released) in central Cook Inlet in higher than normal levels during the halibut fishery in June and July (Scott Meyer, Fishery Biologist, ADF&G, Homer, AK, personal communication). While salmon sharks (*Lamna ditropis*) were caught in fairly large numbers off Afognak Island during the early portion of the salmon season (Kevin Brennan, Fishery Biologist, ADF&G, Kodiak, AK, personal communication).

The incidence of spiny dogfish (*Squalus acanthias*) in ADF&G's coastal surveys dramatically increased in the Kodiak area and Prince William Sound in 1998 (Bill Bechtol and Dave Jackson, ADF&G, personal communication). Frequency of occurrence in trawl survey hauls increased from around 2% of the tows in the early-1980s to around 15% in the late-1980 and 1990s. In 1998, occurrence in tows increased to more than 40%. In the Prince William Sound longline surveys, all shark species combined comprised 4% of the aggregate relative population number with a mean catch rate of 0.29 sharks per skate for 510 skates. In contrast, preliminary data for 1998 indicated an increase to 3.4 spiny dogfish fish per skate for 570 skates, totaling 34% of all fish caught. An increase in spiny dogfish has also been observed in the IPHC's GOA halibut longline surveys (Lee Hulbert, NMFS personal communication)

Some individual species were seen in some uncommon times and/or places, though the individual species may be fairly common in or around the GOA. A Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) was seen in a cove near Haines from May to August on a regular basis. Though Pacific white-sided dolphins occur in this area, they are rarely seen alone and inland for so long (Wynne 1992). Another significant sighting was a Northern right whale (*Eubalaena glacialis*), which was spotted off Kodiak Island during a small cetacean survey by the NMML. Though the location of the sighting is well within the historic range of the right whale, this is the first photographed specimen in the GOA in many years (Waite 1998).

As for birds in the GOA, there were some note worthy occurrences and events. A gray-tailed tattler (*Heteroscelus brevipes*) was spotted, by Andrew Vatter, flying overhead, then landing on the R/V Defiant off Kodiak. The vessel was performing halibut research, just south of the Kenai Peninsula when the bird was spotted. A gray-tailed tattler would be an unusual find in this area. A similar species, the wandering tattler (*Heteroscelus incanus*), is much more common in the area (Vivan Mendenhall, Migratory Bird Management, USFWS, Anchorage, AK, personal communication). During another portion of the halibut research project, a mallard (*Anas platyrhynchos*) was seen flying then landing near the research vessel, R/V Bold Pursuit. Mallards are very common in Alaska, however what made this observation unusual was the vessel was several miles offshore (59° 20' N by 140° 59' W) when the mallard landed near the vessel. Lastly, common murre (*Uria aalge*) die-offs were reported in Cook Inlet, Kodiak, east Aleutians, Seward, and the Bering Sea.

There were only a few unusual occurrences in the Bering Sea and near the Aleutian Islands this year. One of the more publicized occurrences was 3 northern elephant seals (*Mirounga angustirostris*) spotted near and around Unalaska during late June and early July. Elephant seals are known to forage offshore of the eastern Aleutian Islands, but usually not during this time of year and generally further offshore (Reeves et.al. 1992). Another massive bloom of coccolithophore occurred in the Bering Sea this year and was more extensive than the bloom in 1997 (Kruse 1998). This bloom ranged from outer Bristol Bay to the Bering Strait. It is unclear whether the bloom was associated with the murre die-off. In 1997, the coccolithophore bloom was considered the main cause of the massive seabird die-off. As in 1997, Pacific white-sided dolphins and Northern right whales were sighted this year in the Bering Sea (Crab Plan Team, 1998).

There was another poor return to Bristol Bay of sockeye salmon (*Oncorhynchus nerka*). This marks the second year that the Bristol Bay sockeye salmon return was extremely low. Governor Tony Knowles had the area declared as an economic disaster area, due to these poor returns. As well as the sockeye salmon return, the chinook salmon (*Oncorhynchus tshawytscha*) returns to the Yukon and Kuskokwim Rivers were very low.

Both the GOA and Bering Sea had warmer than usual temperatures, though not as great as was observed in 1997. In the Bering Sea, 2° C higher temperatures were documented, while in the GOA some deep ocean temperatures were 1.5° to 2° C greater than usual (Kruse 1998).

This is probably not the limit of unusual occurrences, events or circumstances. However this is the extent of information which was sent or could be specifically located. In the future, more reports from the fishing fleet, as well as other government agencies would be welcomed.

References

Hart, J.L. 1973. Pacific Fishes of Canada. Fisheries Research Board of Canada, Ottawa, Canada pp 740.

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Waite, J. 1998. Northern right whale sighted off Alaska. Marine Mammal Society Newsletter: 6(3) http//:pegasus.cc.ucf.edu/~smm/news63.htm.

Wynne, K. 1992. Guide to Marine Mammals of Alaska. Alaska Sea Grant College Program, Fairbanks, AK pp 75.

REQUEST FOR REPORTS FROM FISHERMEN & COASTAL COMMUNITIES OF UNUSUAL OCCURRENCES, SIGNIFICANT CHANGES AND ANY OTHER ITEMS OF INTEREST SEEN DURING THE FISHING YEAR - 1999

The North Pacific Fishery Management Council requests the help of fishing organizations and companies to encourage fishermen to describe any unusual occurrences, changes in the oceans or stocks during the fishing year.

Unusual occurrences often precede changes in stock distribution, stock abundances, and/or regime shirts. Fishermen are in the best position to see and evaluate these changes. Write down what you noticed, where you noticed and when you noticed it. Your observations will become a permanent record in the Council's annual December Ecosystem Report and you will receive your own copy.

OBSERVATION

VESSEL NAME:________________________ DATE: ________________________________
AREA: _______________________________ REPORTED BY: ________________________

OBSERVATION

VESSEL NAME: ________________________ DATE: ________________________________
AREA: _______________________________ REPORTED BY: ________________________

Mail this form to the North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501-2252 or fax to 907-271-2817. Please feel free to submit photos illustrating your observations.

SEND MY COPY OF THE NPFMC'S DECEMBER ECOSYSTEM REPORT TO
NAME: ADDRESS:

Types of Ecosystem Observations Requested

Gear Changes

How and why was the gear changed?
What effect did it have?
How many people did it?

Groundfish Species Composition and Distribution

Major difference in bycatch ratios.
Unusual absence or presence of a species in an area.

Groundfish Behavior or Physical Conditions

Location by depth.
Migration patterns (moving more quickly, traveling deeper).
Feeding on animals not normally considered prey or low importance prey species.
Unusual feeding or schooling behavior.
Unusual physical characteristics (long and skinny, etc.).
Parasite changes (more, less or new).
Unusual stomach contents

Oceanic and Atmospheric Conditions

Major differences in seawater temperature, color or clarity, current strength or direction.
Major differences in wind patterns, air temperature, cloud cover, or storm occurrences.
Pack ice location or thickness, or time arriving or breaking up (freeze up or break up).

Other Fisheries

Salmon and herring changes in return size, timing or size/sex distributions.
Shellfish changes in size/sex distributions, physical location or catches.
Forage/bait fish changes in schooling, numbers locations or timing.

Marine Mammals and Birds

Unusual changes in numbers (including absence and presence) or behavior.
Unusual concentrations or die-offs.

Terrestrial Influences

Land-mammal or birds absence or presence
Land-mammal or birds concentrations or die-offs.
Unusual vegetation or amounts, or changes in seasonal elements (e.g. pollen and run-off).

Other Unusual or Unexpected Occurrences

Rare or exotic species
Oil spills or ship wrecks
Seismic activity (volcano eruption, earthquake)
Excessive or unusual debris (hundreds of toy animals)
Unusual vessel or aircraft traffic, timing or amount
Any other observations or concerns about the fishery or marine environment.